THE EAST AFRICAN AGRICULTURAL JOURNAL

Issued under the Authority of the East African Governors' Conference and published every other month
JANUARY, MARCH, MAY, JULY, SEPTEMBER, NOVEMBER

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Nutrition and Reproduction

It is generally known that an animal makes use of the food it eats to build up new tissues and to repair existing tissues; and that it also turns food into the energy which is needed for movement, digestion, breathing, the maintenance of body temperature, etc. The relation between the nutrients consumed and the tissues and energy produced has been the subject of considerable investigation, especially in so far as nutrients affecting working capacity and the production of milk and meat. Another important aspect of feeding is its relation to reproduction. The importance of this side of the subject is not perhaps so generally appreciated, although in recent years it has been discovered that the cause, either direct or indirect, of many reproductive troubles is faulty nutrition. The quality and strength of offspring very largely depend on the bodily condition of the parents; poor condition may result in heritable characters in the offspring being completely masked.

One of the major problems of animal husbandry is the maintenance and improvement of racial characters. Racial improvement must, of course, be based on selective breeding, but it is important for farmers to realize that, however wisely their breeding programme is arranged

and carried out, it will not be successful in the long run if nutritional requirements in relation to breeding are not equally understood and provided for. This is true for all kinds of stock—cattle, sheep, pigs, poultry and horses.

It is wasteful to keep on a low diet high-grade cows of European breeds, which are capable of giving a high milk yield; it is even more wasteful to ruin the chances of a good calf of pedigree parents by failure to give the mother the right kind of food, which she requires to produce a calf that will do justice to its pedigree.

Progeny of poor quality is not the only result of the incorrect feeding of breeding animals; sterility may result. The occurrence of sterility in farm animals and particularly in dairy herds is common and in itself is a problem of considerable importance. Reproductive troubles, sterility and abortion occur frequently wherever intensive dairy farming is practised, and may become important under ranching conditions. Until comparatively recently, sterility, abortion, other reproductive troubles and, in fact, poor quality of the offspring were far too frequently put down to disease; it is now known that many of these occurrences arise directly or indirectly from faulty nutrition.

A maintenance ration is not sufficient to enable an animal to produce meat or milk or to perform work; supplementary feeding is necessary. But the type of supplementary feeding best suited to a fattening steer or to a draught horse on heavy duty is not equally the optimum for a pregnant animal. Such an animal would benefit from any supplementary feeding, provided that it was not too rich in carbohydrates, but it is obviously better to know exactly what supplementary feeding is required in the special case and to provide it. The pregnant animal has to build up a foetus and other uterine products, has to make provision for the energy necessary for successful reproduction, and, at the same time, has to maintain its own bodily condition at a level considerably higher than that which is good enough for a "store" animal. For these purposes it is known that certain constituents in the diet are especially needed.

Firstly, extreme leanness and extreme fatness must be avoided. Secondly, the substances specially needed in the diet are proteins, certain minerals, especially calcium and vitamin A. Extra energy is also required. Under-nutrition in a general sense is a frequent cause of sterility and when offspring are born to underfed parents they are weak. On the other hand overfeeding is well known to be detrimental to breeding and may cause sterility. Mineral deficiencies are known to affect adversely both breeding and progeny characters. Deficiency in phosphorus particularly results in poor breeding. Deficiency in calcium, a characteristic of some pastures, is also an important contributory cause. Experiments with small animals under laboratory conditions have shown that the fertility of parents and the health and strength of their progeny have been considerably improved when calcium has been added to the diet. Under certain experimental conditions entailing the feeding to cows of a single fodder plant, such as wheat or maize, it has been found that the addition of calcium to the ration was essential to secure reproduction. In practice, acid soils may give rise to a calcium-deficient diet, and farmers should consequently beware of the possibility of this deficiency. Deficiencies of iron, certain alkalis and iodine also affect reproductive efficiency. Both vitamins A and E are essential to both sexes. It has been shown that without

these vitamins reproduction is interfered with and those offspring which are born are weak and unhealthy and may be degenerate in quality compared with their parents. Protein is an essential in the diet of the pregnant animal; it is required to build up the body of the foetus. As has been said before, energy-producing substances are also required.

These notes are intended to bring to the notice of the reader the importance of the relation between nutrition and reproduction and they will serve as an introduction to two articles which appear elsewhere in this issue. In an article entitled "Nutrition and Reproduction," which is reprinted from the *Journal of the Ministry of Agriculture* (England), Vol. XLV, No. 8, Professor Crowther discusses in some detail the nutritional requirements of breeding animals. He explains how energy is stored by the pregnant animal in the uterine products and how this energy is later expended at the time of birth. The rate of energy storage increases as gestation progresses. He explains further that although the total food requirement during pregnancy is not much increased, the comparative protein requirement is increased, especially towards the end of gestation. Storage against the future drain of lactation must also be provided. Professor Crowther makes clear the important point that, unlike carbohydrates, fats and proteins, which are interchangeable for the supply of energy, minerals are completely specific in their function and are not interchangeable. The effects of mineral deficiencies are generally cumulative. From a perusal of this article readers will get an indication of the ways in which diet should be modified for pregnant animals.

In a contribution entitled "Calving Success in Relation to Supplementary Feeding," by H. L. Brett, Agricultural Assistant, Tanganyika Territory, which also appears in this issue, the practical side of this question is emphasized by a record of the improvement in calving of animals, normally grazed on very poor pasturage, by the use of judicious supplementary feeding. Incidentally, this record well illustrates the need for grazing improvement from the dietetic point of view, which is a related problem of the greatest importance in East Africa. It will be noted in the tabular record in Mr. Brett's contribution that the supplementary feeds were largely composed of such substances as groundnut cake, cotton-seed cake, minerals, greenstuffs, and cod-liver oil, i.e. substances rich in protein, minerals or vitamin A. The pasture in this case was partially deficient in protein and soluble ash (mineral matter).

Stress has here been laid on the nutrition and bodily condition of animals which are actually pregnant. It cannot be too strongly emphasized, however, that animals used for breeding, both male and female, should at all times be maintained in a thoroughly fit condition; nutritive effects are frequently cumulative. This statement embraces the special case of the maintenance of lactation in the female which breeds regularly, and special importance attaches, of course, to the care of the cow in the dairy herd. At the Naivasha Experiment Station of the Kenya Veterinary Department, where reproduction in animals is being studied, it has, for instance, been found that the duration of oestrus in Zebu cows grazed on good pasture was not lengthened by supplementary feeding, indicating that the pasture itself in this case was adequate, but that its duration was shortened in cows fed on pasture deficient in protein and phosphorus. It should also be remembered that the insurance of healthy progeny of good quality is here only brought

up to the stage of birth. Their after-feeding is equally important, but is a separate subject.

In preparing a ration for a pregnant animal it is necessary to increase the amount of protein-rich foodstuffs, such as groundnut cake, in the normal ration; to make sure that there is no mineral deficiency; and, if there is, to remedy it and to feed leafy greenstuffs to insure a supply of the requisite vitamins.

A Series of Feeding Notes

In this issue also appears the first of a bi-monthly series entitled "Notes on Feeds and Feeding," compiled by the Department of Agriculture, Kenya. These notes will deal with all aspects of feeding problems and it is hoped that they will be of help to farmers. The instalment which appears in any one issue of the *Journal* has especial reference to the seasonal conditions of the two months following its publication.

The Efficiency of African Labour

The economic development of Central and Southern Africa rests upon the labour of Africans. This is so whether we are thinking in terms of European enterprise or development in native areas, and a fundamental problem facing settlers and adminstrators is the efficient direction of this labour. Upon it profits and native development alike depend. On all sides we hear complaints of the inefficiency of African labour, of its scarcity and of the high cost of supervision so far as they influence profits. On the other side, complaints are made of the low wages received by Africans, the consequent heavy burden of taxation, and the low standard of living. The "dual mandate" is obviously a matter of efficiency of labour. Further, the admitted social harm done by drawing a large proportion of the male population intermittently from their homes makes economy in its use a vital consideration.

Considerable sums have been spent in providing capital for development, studying the composition and capabilities of the soil, introduction of economic plants and control of pests and diseases. Something has been done in the way of improvement of transport facilities and introduction of labour-saving devices to increase the output of labour. In some territories, too, the effect of diet and general health on efficiency has been studied. In general, however, efficiency in the actual work processes has received little study, or has been studied only by individuals in the ordinary course of their work, and so the experience gained has not been recorded or codified. In more advanced countries "industrial psychology"—a not very happy term—has received increased attention of late years, and it might be thought that the field for improvement is greater among African tribes because the starting point is so much lower.

In this connexion much interest attaches to some observations made in connexion with the clearing of bush as a means of tsetse-fly control in Tanganyika.

A note published in 1933[1] described preliminary investigation into the effect of substituting task work for day work. Previously "gangs of comparatively raw native labourers had been worked on the ordinary day principle, the European Reclamation Assistant in charge, with his native staff, pushing the labour as hard as possible to obtain the maximum results within the limits of the hours of the day's work". "Task-work had never been

[1] "Task-work versus Day-work Methods in Anti-Tsetse Clearings," S. Napier Bax, in *Tropical Agriculture*, Vol. X, No. 9, Sept. 1933; pp. 249 *et seq.*

adopted to any extent owing to what was considered the insurmountable difficulty of assessing a fair day's work." It was found necessary for the supervisor to "get the feel" of the work, in order to assess the daily task with the dual object of saving expenditure to the employer and time to the labourer. When the trials were actually carried out, however, there resulted an increase of from 21 per cent to 79 per cent, according to the nature of the work, in the amount accomplished per day. To the worker, there was a saving in time of from 6 per cent to 15 per cent. The greater advantage was obtained on the lighter kinds of work, where the opportunity for dawdling was greater.

The introduction of task work necessitated the supervisor demarcating tasks for the next day, but on the other hand it released him from the "soul-destroying business of driving labour". Task work appealed to the labourers, who were glad to earn the reward of getting off early. "It was found to be a fatal policy to exploit the labour by increasing unduly the daily tasks. The fundamental principle of partnership had to be maintained." There was no falling off in the quality of the work, as the supervisors, being released from the necessity of urging the men on, could devote more time to observing the standard of work being done.

So far the inquiries do not carry us beyond the stage reached by planters in East Africa. Task work is the general rule, except where quality of work is the main consideration. In a further study,[1] however, entry was made into a new field. Tests were made to indicate the comparative efficiency of different methods of performing the actual manual processes.

The first test was designed to see if any improvement could be effected by substituting European methods of working for the customary native method. The native holds his axe in a left-handed manner. That is to say, when cutting on the right side of a tree he has his left hand nearer the head of the axe. The action is a chopping motion rather than a swing, and appears extremely awkward. On test it was found that there was no improvement from changing over to the European grip.

The labourers employed in this test had received no instruction in the use of the European grip. A second test carried out after they had been given a day's instruction in how to swing their axes had the result of producing an improvement in the amount of effective work done with the European grip, but, surprisingly, an even greater improvement in the output with the native grip. There was a positive result from the improved technique of swinging the axe, but no improvement from the change of grip. Subsequent observations showed that even the improvement from swinging the axe in the European manner was soon lost again. The gang forgot most of what it had been taught.

Perhaps these results are not very surprising. You cannot teach an old dog new tricks in such a short time. The results accord with the experience of the reviewers in trying to substitute a two-handed for a one-handed method of picking coffee, with the same experimental method of changing the workers alternately from one technique to the other. It is possible that if gangs who had become thorough habituated each to one particular method were compared, sources of experimental error being eliminated by

[1] "Some Factors Governing the Efficiency of African Labour in Bush Clearing Work," S. Napier Bax and G. T. Wheeler, *Tropical Agriculture*, Vol. XV, No. 7, July 1938; pp. 154 *et seq.*

replication, a positive result would be shown.

Tests of the effect of lengthening the grip likewise yielded no result. In comparisons between tempered European axes and soft-metal spike-headed native axes there was again no very definite result with a good type of native axe, but with a poor type of native axe the loss of output varied between 27 per cent and 55 per cent. The authors remark that the full inefficiency of the native axe was not brought out because under the conditions of the experiment the axes were being continually re-sharpened between bouts of test work and the loss of time from more frequent sharpening did not appear in the figures.

Experiments in provision of rest-pauses (with and without light refreshment) indicated no significant increase in output, though at the same time a rest pause of half an hour did not result in any decrease.

More spectacular results were seen when blunt axes were compared with sharp axes. Compared with axes sharpened at the beginning of the morning's work, blunt axes, used as they were left at the end of the previous day, produced with the hard *Acacia spirocarpa* only 57 per cent and 68 per cent of the output and with the soft *C. Fischeri* only 52 per cent. But axes sharpened only at the beginning of the day gave only 86 per cent and 83 per cent of the output given by axes sharpened both at the beginning and half-way through the day. It is, of course, to be expected that blunt tools will be less efficient, but the experiments are valuable in giving a quantitative value to the degree of inefficiency, leading to an estimate of the loss involved.

These investigations are a mere beginning in a field of study which is a very large one. Its importance can hardly be underrated. It should start from basic physiological, psychological and social factors and should range over the whole field of economic incentives. Many fundamental questions at once occur to the imagination. Is the tax machine the best economic incentive under present conditions? Can anything be done by industrial co-operation to stimulate legitimate wants and lead to attempts to satisfy them? Is task work the last word in labour organization, or would some closer degree of economic co-operation be an improvement? What are the technical factors limiting output of effective work per unit of effort expended? Is any permanent improvement to be expected without substitution of resident for intermittent labour? Why do Africans sometimes hesitate to adopt what appear to agricultural and veterinary officers to be obvious improvements? Is it too much to hope that some day governments, investors in producing concerns and commercial interests will mutually conclude that these and related questions need systematic study if Africa is to contribute its full quota to world development? Will they conclude that efficiency in manual no less than in clerical work is largely a matter of education? Will the result be the creation of an African Institute of Industrial Relations?[1]

[1] In connexion with the above discussion on the efficiency of African labour attention is drawn to the article in this number by Mr. Fuggles-Couchman. He gives the results of a preliminary investigation—of great importance for all concerned with native agricultural production—into the number of working days needed for planting and harvesting certain areas of crops under defined smallholding conditions.—*Ed.*

Nutrition and Reproduction*

By CHARLES CROWTHER, *M.A., Ph.D., Harper Adams Agricultural College*

The maintenance of regular and healthy reproduction coupled with a sound breeding policy is clearly essential to the development of successful animal husbandry. Until recent years the major causes of reproductive troubles were commonly sought in the field of disease, but conclusive evidence is now available that in very many cases the basic causative factor primarily arises from faulty nutrition. The effects of such factors, moreover, are not necessarily exercised directly upon the sex organs, but may affect their activities only indirectly through the establishment of abnormalities in other parts of the body whose healthy co-operation is essential to the optimum working of the reproductive processes.

That general bodily condition may react upon reproductive efficiency has long been known to observant breeders. Extremes of leanness and fatness must be avoided. The half-starved animal, whether male or female, is likely to be slow in arriving at puberty and of low breeding efficiency thereafter. The female in such condition may for a time produce healthy offspring, but only through incurring a strain upon her body that may soon cause the production of dead or weakly offspring and permanent damage to herself. The underfed male will show his weakness in reduced number and vigour of the sperms. At the other extreme, the detrimental effects of over-fatness are revealed in the widespread experience that in both sexes the maintenance of animals in "show" condition for more than short periods is generally accompanied by low fertility.

Under-nutrition may arise from a general deficiency of energy supply or from deficiency of one or more of the specific essential factors, such as vitamins or minerals, or from the combined effects of more than one deficiency, and the nature of the reaction upon reproductive activity will vary with the character of the nutritional defect. In the female an effect that seems to be common to all types of nutritive deficiencies is a disturbance of the oestrous cycle, leading to irregularity or in severe cases to actual cessation.

ENERGY REQUIREMENTS

The minimum energy requirement for reproduction in the female is obviously that represented by the energy stored in the form of new tissues in the growing foetus and its membranes, in the enlargement of the uterus and the development of the mammary glands. To estimate the actual energy requirement, however, this minimum must be increased, since even under the most favourable conditions it is hardly possible for the whole of the available energy that is applied to the reproductive process to be stored up in the new tissues. In other words, we must provide not merely for the material produced but also for the work of reproduction. Each of these items, which together form the total energy requirement, will vary at different stages of the gestation period.

That the rate of storage of energy in the foetus and other uterine products rises steadily as gestation progresses has been well demonstrated in studies with young sows at the Illinois Agricultural Experiment Station. In these studies it

* Reprinted from *The Journal of the Ministry of Agriculture*, Vol. XLV, No. 8, 1938, pp. 797–805.

was found that with a sow producing a litter of eight pigs the daily storage of energy rose from less than 2 Calories in the first week to 272 Calories in the sixteenth week of gestation. Similar increases were also recorded in the storage of protein and mineral elements. For the whole period the average daily storage of energy was 104 Calories, and assuming that the additional storage of energy in the growth of the mammary glands would not exceed 10 per cent of this figure, an estimate of an average daily requirement of 115 Calories of net energy to cover the specific needs of reproduction was arrived at. When this is compared with the net-energy requirement for maintenance of gilts of the weight used in these studies (200 lb.), which was put at 2,000 Calories, it will be seen that the extra energy requirement of the in-pig gilt as compared with the "empty" gilt amounts to no more than 5 or 6 per cent, and even at its highest point in the closing week of gestation when it may have risen to 300 Calories, this represents but a 15 per cent addition to the basic maintenance requirement. If these energy figures be converted into terms of the corresponding weights of digestible nutrients, the ratios will remain much the same and we may conclude that as far as extra energy supply is concerned the additional requirements for pregnancy of the sow are trivial in the early stages of gestation and at no stage are likely to exceed 20 per cent of the basic maintenance requirement. With longer period of gestation of the cow, the extra energy requirement in proportion to the size of the animal is probably even smaller.

These computations leave out of account, however, the bodily condition of the mother herself, and if this is low at the onset of pregnancy it will clearly be advisable to feed on a more liberal scale until the desirable state of bodily fitness has been attained. This is all the more important since some draft upon the reserves of the body is almost certain to be made, even with abundant food supply, to sustain the milk flow subsequent to parturition, when it reaches its maximum level.

A further point to keep in mind in connexion with these estimates of food (energy) requirements is that they assume that the ration is adequate with regard to all other essential factors. Should there be a deficiency of protein or phosphorus, for example, then probably a greater amount of food will be required to secure the same level of storage of energy. The nature of the ration requires separate consideration therefore, apart from the question of energy supply.

Protein Requirement

Bearing in mind that the dry substance of the foetus and other products of gestation is rich in protein, it follows that the trend of protein storage with advance of gestation will be similar to that of energy, small in the early stages and rising to a relatively high level at the end. Thus, in the Illinois studies referred to above the daily rate of storage of crude protein rose from 0.5 grm. in the first week to 33 grm. in the sixteenth week. This is a far smaller relative increase than that found in respect of energy storage, which is to be expected since, as the foetus develops, an increasing proportion of the retained energy is stored in the form of fat.

Over the whole period the average rate of protein storage was 14 grm. per day,[1] which may be raised to 16 grm. to allow for protein stored in the increase of mammary gland. As to how much digestible

[1] This figure agrees well with that of 12.5 grm. obtained by Evans in experiments at Cambridge.

protein should be included in the food supply to provide for this storage, this will depend upon the "biological value" (or "quality") of the food protein. If this be assessed for common types of rations at 50 per cent, the average daily requirement of digestible protein in the food to secure an average storage of 16 grm. would be 32 grm. Similarly, to provide for the 35 grm. daily storage in the last week of gestation about 70 grm. of digestible food protein will be needed. According to American estimates the pig of 200 lb. live weight requires for maintenance about 100 grm. of protein per day. German estimates give the much lower figure of 60 grm., but even taking the higher figure it will be seen that the additional requirement for food protein imposed by pregnancy is no less than 32 per cent on the average of the whole period and 70 per cent in the closing stage of gestation. Although, therefore, the total food requirement during pregnancy as indicated above may be but little increased, the protein requirement is substantially increased and therefore the composition of the ration must be adjusted, by reducing the cereal fraction and increasing the protein-concentrate fraction, to ensure the necessary increase of protein supply. The same principles apply to other classes of live stock, but where the rate of development is slower the relative increase of protein supply required will be less. Thus, Maynard estimates that the maintenance requirement for protein for the cow may be increased during gestation by an average of 17 per cent over the whole period, or 40 per cent in the closing stage.

These are probably under-estimates of what is *desirable*, since here again, as also for energy storage, regard should be had to the desirability of enabling the parent to store up a reserve of protein in her body, apart from the bare needs for reproduction, in order to provide some insurance against the drain to which she may be exposed later when the heavy demands of lactation have to be met.

Vitamin Requirements

Despite a considerable amount of research, the precise significance of vitamin supply for reproductive efficiency is still not clearly defined. Only for vitamins A and E does there seem to be a clear case for postulating that the maternal diet must include extra amounts to cover any specific requirement for reproduction. For the welfare of the mother herself the whole range of vitamins may be of importance, and certainly the A and D vitamins, whilst a liberal supply of these vitamins to the mother makes possible the accumulation of reserves in the foetus, which will be valuable in the early stages of post-natal life. That there is a specific requirement for vitamin D for reproduction would seem probable, but conclusive evidence as to this has not yet been obtained, especially as regards farm animals.

That an adequate supply of vitamin A is essential for efficient reproductive activity has been established for both sexes. In the male a deficiency of this vitamin quickly induces a marked lowering of fertility. In the female the first sign of vitamin-A deficiency is commonly the development of irregularity of oestrus, which ultimately may cease entirely if the vitamin deficiency is very severe. If fertilization takes place, the gestation may be prolonged and terminate in difficult parturition; the placenta will often be abnormal and the incidence of foetal death and resorption, or of abortion, will be increased. These effects arising primarily from placental injury are said to differentiate cases of vitamin-A deficiency from foetal death due to deficiency of vitamin E which is occasioned more directly by defects in the foetal tissue

itself. The diagnosable symptoms of vitamin-A deficiency vary somewhat according to the species of animal and the severity of the deficiency.

Little is known as to the minimum requirements of vitamin A for reproduction, but there is evidence that they are at any rate greater than those for maintenance. The simplest practical safeguard against deficiency of this vitamin lies in the supply of leafy greenstuffs, either fresh or artificially dried. Where this is not available, or with animals, such as the pig, that can only digest relatively small quantities of roughage, the inclusion of yellow maize in the ration will be helpful. There is evidence, however, that pig-feeding rations, even when relatively large proportions of yellow maize are included, are often barely adequate in supply of vitamin A unless either a store of the vitamin has been built up in the animal during the pre-natal and early post-natal periods, or some additional good source of the vitamin, such as greenstuff or cod-liver oil, is added to the ration. As to the former alternative, experiments at Cambridge and elsewhere have demonstrated that only a very small fraction of the vitamin A of the maternal food-supply can be stored up in the offspring, so that with a rapidly growing animal like the pig the most liberal pre-natal supply of the vitamin to the mother will not for long safeguard the offspring against deficiency in the post-natal food supply.

The basic need for vitamin E for reproductive efficiency has been demonstrated, but there is little evidence as yet that breeding troubles due to deficiency of this factor are met with more than very rarely in farm practice. Nor, indeed, is it to be expected that this class of trouble would be often met with in view of the supply of the vitamin in greenstuffs and the germ of cereal grains. Should the exigencies of flour milling, however, lead to a greater removal of the germ from the "offals" than is as yet customary, the possibilities of vitamin-E shortage in breeding stock kept indoors with little or no greenstuff or unmilled grain would need to be examined.

Mineral Requirements

The general importance of an adequate supply of mineral elements for the building-up of the developing foetus is obvious. Calcium and phosphorus are essential for bone formation, alkalies for the proper functioning of the body fluids, iron for the production of the necessary haemoglobin in the blood, iodine for the efficient working of the thyroid gland, and other mineral elements for other specific purposes. There is little possibility with these mineral requirements of off-setting a deficiency of one element by a surplus of another of similar character, say of potassium by sodium.

For the purposes of energy supply, carbohydrates, fats and proteins are to a large extent mutually replaceable, but in regard to mineral supply the functions in the body of each particular element are largely specific and can therefore only be met by the supply of that element in the food.

Judged in terms of quantity, the most spectacular mineral requirement for growth, and therefore for reproduction, is that for calcium and phosphorus, since these form so large a part of the structure of the bones. The magnitude of this requirement explains also why deficiencies of calcium and phosphorus are more frequently the cause of trouble in practical animal husbandry than any other form of mineral shortage.

The direct incidence of deficiency of calcium or phosphorus on reproductive efficiency has been conclusively demonstrated by experimental work in many

parts of the world. As an example, the classic work of Theiler and his associates with cows on the phosphorus-deficient grazing areas of South Africa may be quoted. When the grazing was supplemented by bone meal or other phosphorus concentrates the calf crop was about 60 per cent greater than when no such supplement was given. Similar effects upon fertility also accompany calcium deficiency, which causes an increase in the number of progeny born dead or weakly.

Over the world in general, calcium deficiency is probably less widespread than phosphorus deficiency, but there are many areas, including a large part of Britain, in which the position is reversed. In housed animals fed mainly on grain and other concentrated foods it is also more often the supply of calcium than of phosphorus that needs special attention.

The effects of shortage of these elements on reproduction are the more insidious through the gradual character of their development, since for a time, which may be prolonged, the deficiencies of the food may be made good by depletion of the supplies of calcium and phosphorus in the maternal skeleton. Even with a continuous deficiency, therefore, little effect may be apparent at the first, or even at the second pregnancy, and when eventually it does appear the general tendency will be to look for the cause in some recent change of diet or treatment rather than in the long-continued (but unsuspected) dietary mistake. The unwisdom of allowing a drain upon the mineral reserves of the maternal body during the gestation period becomes actual folly when it is remembered that this period is followed by the period of milk production, in which for a time some further depletion of the maternal mineral stores is almost inevitable even with a liberal supply of minerals in the food.

It is difficult to arrive at reliable data for the calcium and phosphorus requirements of the pregnant animal since these must cover not only the amounts actually stored in the contents of the uterus but also the maintenance needs of the mother, who should indeed receive more than this in order to enable her to build up reserves in her bones with which to meet the subsequent strain of lactation. As to the actual storage in the growing foetus, the data obtained in the American studies with pigs referred to above indicated that about 95 per cent of the calcium and 90 per cent of the phosphorus were stored up in the second half of pregnancy, and no less than 60 per cent and 50 per cent respectively were stored up in the last three weeks. It would seem, therefore, to be more particularly in the later weeks of pregnancy that attention should be given to the adequacy of the supply of these two mineral elements.[1] The same applied to the storage of iron, except that in this case the rate of increase of storage increased more gradually from start to finish, although about 80 per cent of the total was stored in the second half of the period and nearly 40 per cent in the last three weeks.

In other American studies the conclusion was reached that the ration of pregnant sows should contain not less than 0.4 per cent of calcium, or say 0.3 per cent rising to 0.5 per cent, with rather less

[1] On the other hand, results obtained by Evans at Cambridge indicated that, even with a liberal supply of calcium in the food, the enhanced requirements of the foetus in the later stages of pregnancy were largely drawn from the maternal reserve, so that the wiser plan may be to give calcium liberally in the first half of the gestation period in order to ensure that this reserve is fully developed when it is needed, rather than to rely upon direct assimilation from the food at the time when the need is greatest.

phosphorus. For gilts the proportion would need to be a little higher to cover the gilt's own growth requirements.

As regards ruminant animals, with their longer period of gestation, the daily requirement of minerals is less in proportion to body size. Thus, in the ewe it is estimated that 0.2 to 0.35 per cent each of calcium and phosphorus in the daily ration will be adequate. In the cow a still lower proportion, say 0.15 to 0.25 per cent, is probably adequate for maintenance and reproduction, but here the estimation of the requirements for the needs of production is complicated in the first pregnancy by the simultaneous need for the purposes of growth of the heifer, whilst in later pregnancies a still greater complication arises if, as is usual, milk production is continued through the greater part of the new gestation period. In practice, therefore, it is hardly possible or indeed necessary to discriminate between the requirements for the various needs which together make up the total requirements. A rough standard which, judged by American data, will probably not be far wide of the mark for average conditions, can be arrived at by taking a minimum requirement of 0.10 per cent each of calcium and phosphorus in the dry matter of the food for the "empty" dry cow, increasing this by 0.07 per cent for the dry, in-calf cow, and by a further 0.07 per cent for each gallon of milk. On this basis, the cow of average size, in-calf and giving 2 gallons of milk daily would need in her daily ration about 0.3 per cent each of calcium and phosphorus.

The requirement for other mineral elements need only be dealt with briefly, since it is probably only rarely in ordinary breeding practice that actual deficiency with regard to them arises. It is true, for example, that the need of the pregnant animal for iron is probably twice or thrice as great as the maintenance requirement, but unless the animal is kept under highly artificial conditions, such as are for many reasons undesirable for breeding stock, it is unlikely that even this enhanced iron requirement will not be met by the ordinary food supply. The risk is certainly greater with a prolific quick-growing species like the pig than with slower-growing species, and for the in-pig sow, without making any nice calculations as to iron supply, it may be worth while to enrich the dietary slightly with iron on the off-chance that some little of it may be stored in the young pigs, which thereby may be better equipped to avoid the post-natal risks of anæmia.

The only other mineral element that perhaps needs special mention is iodine, but as to whether deficiency of this element is likely to be at all common in practice it is difficult to obtain clear guidance. Since iodine is an essential factor in the activities of the thyroid gland, which include an intimate influence upon the processes of reproduction, it is obviously very important that there should be no risk of shortage of iodine in the breeding animal. The evidence from practical feeding experiments with iodine supplements to ordinary rations is very conflicting, and certainly does not as yet warrant any general recourse to iodine supplements for breeding stock. A deficiency of iodine so pronounced as to affect reproduction seriously will almost certainly establish a goitrous condition in the parent animal, and where such condition can be diagnosed an increase in iodine supply is clearly required. In the light of existing information we are inclined to agree with Maynard that "there is no conclusive evidence that the feeding of additional iodine to breeding animals is helpful except in the specific situations where goitre is occurring, or that it has

any benefits other than goitre prevention. . . . Since the danger of over-dosage with iodine is a real one, it seems wise to restrict its use to the prevention of goitre and related troubles in areas where they otherwise occur, until positive benefits for other purposes have been clearly proved."

Finally, a word may be said as to the possible need for a supply of salt to the breeding animal. No information is available on this point, but since there is evidence that deficiencies of salt supply may arise in respect of quick-growing animals like the pig and chicken it may perhaps be as well to keep in mind a similar possibility in regard to pre-natal growth, although in this case the maternal body will probably provide an adequate regulator of supply to the uterus, even on a salt-deficient diet. It is plain commonsense, however, that a deficiency which can be foreseen should be avoided.

Calving Success in Relation to Supplementary Feeding

AT THE AGRICULTURAL TRAINING CENTRE, NYAKATO, BUKOBA

By H. L. BRETT, *Agricultural Assistant, Tanganyika Territory*

The history of the herd commences in 1933 when some cattle (Ankole) were borrowed from a local chief and others (Zebu) were imported from Musoma. There were two objects in the establishment of a herd at Nyakato: one, experimental work by the Veterinary Department, and the other, the making of compost manure for use on the demonstration plots of the Agricultural Training Centre. Latterly there has been no Veterinary Officer stationed in Bukoba and the herd has been handed over to the Agricultural Department entirely, but the management of the herd in regard to supplementary feeding has been continued on the lines advised by the Veterinary Department.

LOCAL PASTURE

The extreme poverty of the pasture grasses in the Bukoba District had, of course, long been realized. Analysis of a sample which consisted of two common grasses—*Eragrostis blepharoglumis* K. Schum. and *Trichopteryx kagerensis* K. Schum. (*Loudetia kagerensis* C. E. Hubbard ex Hutch.), principally the former—at the Royal (Dick) Veterinary College, Edinburgh, revealed that they are of extremely poor quality. The report stated that they are low in protein and particularly low in soluble ash, especially calcium, magnesium, chlorine, potassium and sodium; also that of all the material analysed from Africa and elsewhere this was certainly the poorest in every respect. Subsequent analysis of selected indigenous grasses from composted paddocks at Nyakato—*Urochloa bifalcigera* Stapf. (known locally as Kabale grass) and *Coelorhachis afraurita* Stapf. (resembles Kikuyu grass and is known locally as Maruku grass)—showed a very decided improvement, but all the grasses have an excess of phosphate over calcium, which is a bad feature.

This short description of local pasture conditions shows that the cattle could not be expected to thrive unless deficiencies were remedied. For this purpose various items of supplementary diet were introduced from time to time. They were given in earlier years to cows in calf or feeding a calf; then experimentally with varying rations for different beasts, and finally with a full ration for every beast.

The chart is self-explanatory; a brief summary of results may, however, be given in conclusion, taken from each column:—

Column I.—The weight at birth has risen steadily from 20 lb. to over 40 lb.

Column II.—The fact that in 1937-38 eight heifer-calves were born to three bull-calves can only be regarded as good luck.

Column III.—No premature births or abortions are recorded latterly.

Column V.—No general improvement in the rate of calving is apparent except in the last calving, which was after an interval of just under eleven months. There are indications, however, that the average interval will be appreciably reduced in the next lot of calvings.

Column VI.—Deaths from sickness have been greatly reduced; nearly all the calves born in 1937 and 1938 have had East Coast fever but have been able to resist it, whereas formerly it was frequently fatal.

Conclusion

The above constitutes an interesting record of the improvement of a herd, in an area of notoriously poor pasture, by means of supplementary feeding, but it cannot be claimed that the results, as they stand, are of great value to the local native owners of cattle on account of the expense of imported items, i.e. the cakes.

A programme of supplementary feeding is now under consideration with the object of supplying deficiencies so far as possible with items procurable locally at little or no cost.

RECORD OF CALVINGS, NYAKATO

1933–8

	Date	I Weight at birth	II Sex B. Bull H. Heifer	III Remarks at birth	IV Dam	V Period since last calving	VI Subsequent history	VII Age at death	VIII Feeding programme
		Lb.				*Months*		*Mths. days*	
1	6–10–33	—	B	Normal ..	B Ankole ..	—	Died, accident ..	15	1933—No record of supplementary feeding.
2	17–12–33	—	B	Normal ..	O Zebu ..	—	Died, accident ..	15	
3	17–12–33	—	B	Normal ..	N Zebu ..	—	Doing well ..	—	
4	18–12–33	—	H	Normal ..	M Zebu ..	—	Doing well ..	—	
5	14–1–34	—	H	Premature, dead	R Zebu ..	—	Dead	—	1934—A little groundnut cake and salt were fed only to cows in calf or feeding calves.
6	3–2–34	22	H	Normal ..	U Zebu ..	—	Doing well ..	—	
7	9–2–34	—	H	Premature, alive	V Zebu ..	—	Died, weak premature	Few hours	
8	24–2–34	—	B	Born dead ..	T Zebu ..	—	Dead	—	
9	25–2–34	9	B	Premature, alive	X Zebu ..	—	Died after a few days	4	
10	12–3–34	29	B	Normal ..	W Zebu ..	—	Died, E.C.F. ..	19	
11	20–3–34	20	B	Normal ..	K Zebu ..	—	Died, E.C.F. ..	26	
12	23–3–34	23	H	Normal ..	Q Ankole ..	—	Doing well ..	—	
13	2–4–34	20	B	Normal ..	E Zebu ..	—	Died, E.C.F. ..	3 10	
14	9–4–34	22	B	Normal ..	J Zebu ..	—	Died, E.C.F. ..	4 27	
15	19–4–34	36	B	Normal ..	Z Ankole ..	—	Doing well ..	—	
16	24–4–34	25	B	Normal ..	S Zebu ..	—	Died, E.C.F. ..	3 20	
17	8–6–34	21	B	Weak	H Zebu ..	—	Dead	—	
18	6–1–35	—	B	Premature, dead	C Ankole ..	—	Dead	—	1935—A little groundnut cake and salt were given to all the herd, and edible cannas started.
19	28–8–35	36	B	Normal ..	O	20½	Died, snake bite ..	29 15	
20	24–10–35	23	B	Normal ..	E	19	Doing well ..	—	
21	26–10–35	23	B	Poor, malformed	R	21½	Died, undiagnosed ..	5 19	
22	14–12–35	33	B	Normal ..	W	21	Died, snake bite ..	19 3	
23	24–12–35	25	H	Normal ..	M	24	Died, E.C.F. ..	2 10	
24	29–12–35	25	H	Normal ..	H	19	Doing well ..	—	
25	8–1–36	26	B	Normal ..	T	22½	Died, white scour ..	29	1936—Various combinations composed of cotton seed, sesame cake, rice tailing, groundnut cake and mineral mixture given experimentally. Bone meal, cod-liver oil to cows that had fallen off badly in condition, stall feeding of elephant grass, cannas and leaves of local crops, e.g. sweet potato, etc.
26	3–2–36	32	B	Normal ..	N	25½	Doing well ..	—	
27	29–2–36	15	B	Premature, alive	U	25	Died, weak ..	5	
28	4–3–36	30	B	Normal ..	B	29	Died, white scour ..	22	
29	18–4–36	30	B	Normal ..	UK Ankole ..	—	Died, undiagnosed ..	3 14	

RECORD OF CALVING, NYAKATO

1933–8

	Date	I Weight at birth	II Sex B. Bull H. Heifer	III Remarks at birth	IV Dam	V Period since last calving	VI Subsequent history	VII Age at death	VIII Feeding programme
		Lb.				Months		Mths. days	
30	14–6–37	35	H	Normal ..	No. 7 Ankole	—	Doing well ..	—	1937 and 1938—For all the Herd. *Protein concentrate ration :* Groundnut cake .. .. .. 1 lb. Sesame cake .. .. .. 1 lb. Cotton seed .. .. .. 1 lb. Rice tailings .. .. .. 2 lb. *Mineral mixture :* Salt, 15 lb. .. .. Iron sulphate, 1 lb. .. Sulphur, $\frac{1}{2}$ lb. .. .. Potassium iodide, 2 oz. .. Lime, 8 lb. .. .. } 1 oz. Bone meal, 1 oz. *Carbohydrate and roughage ration :* Elephant grass, edible cannas, etc, 12 lb. daily. Grazing *ad lib.*
31	24–6–37	50	H	Normal ..	O	22	Doing well ..	—	
32	25–6–37	40	B	Normal ..	S	38	Doing well ..	—	
33	24–12–37	40	B	Normal ..	R	26	Doing well ..	—	
34	27–12–37	41	H	Normal ..	T	$23\frac{1}{2}$	Doing well ..	—	
35	7–1–38	42	B	Normal ..	E	$26\frac{1}{2}$	Doing well ..	—	
36	15–1–38	40	H	Normal ..	H	$24\frac{1}{2}$	Died, E.C.F. ..	2 18	
37	14–3–38	40	H	Normal ..	M	$26\frac{1}{2}$	Doing well ..	—	
38	26–3–38	38	H	Normal ..	N	26	Doing well ..	—	
39	7–5–38	40	H	Normal ..	K	$49\frac{1}{2}$	Doing well ..	—	
40	14–5–38	44	H	Normal ..	O	$10\frac{2}{3}$	Died, E.C.F. ..	22	

SUMMARY

Year	Number of calves born	Number of premature	Number of Deaths: Accident	Number of Deaths: Sickness (includes prematures and born dead)	Number of Deaths: Total	Average weight at birth (excluding prematures)	Percentage of deaths (excluding accident)
						Lb.	Per cent
Part 1933–1934	17	4	2	10	12	24·2*	58·82
1935–1936 ..	12	2	2	7	9	28·3	58·33
1937–Part 1938	11	Nil	Nil	2	2	40·9	18·18
Total ..	40	6	4	19	23	31·1	45·11

*Earlier weights not recorded

Indigenous Plants for the Garden

By MAJOR F. CHATER JACK, *D.S.O., M.C., Mount Elgon, Kitale, Kenya Colony*

Interest in the flowering shrubs and plants found wild in the bush and in the open grasslands is now greatly on the increase. Many gardens give special space for them or introduce them into mixed shrubberies or herbaceous borders, where they get the cultural attention they deserve. There are still people, however, who almost despise anything which they realize is indigenous; who will go so far as to admire some plant unknown to them, and, on being told that it is indigenous, immediately lose all interest. This attitude of mind is difficult to understand, but may possibly be explained by two facts.

Many of the finest and showiest flowering plants get little chance to grow to perfection or spread into large masses of colour in their natural surroundings. They are the prey of game and cattle, are attacked by grass fires or have to struggle for existence amongst dense surrounding undergrowth. Again, and possibly for much the same reason as before, some of the finest of our plants are found as isolated specimens and quite a lot of conscientious searching has to be done before half a dozen of the same species can be found by the collector.

The fact remains, however, that more and more of us who live in this country are appreciating the value and interest of indigenous plants in our gardens. Kenya probably offers a greater range of climatic conditions for its size than any other country; hence the fact that all tastes in life can be catered for when it comes to choosing a home in the country. In the same way each district offers a new field of search to the horticulturist and the botanist.

The object of this short article is to suggest a very few of the shrubs, herbaceous and bulbous plants which can be collected in the country and which are a worthy introduction into any garden. It is hoped that the lists may be some help to those who have not yet thought of the idea of a wild garden or of wild subjects in their existing borders, as well as to those who have made a beginning and wish to add to it. There are many, again, who are far ahead of the writer in their knowledge of our Kenya flora, and from those it is hoped we will have subsequent articles with a greater scope than this.

It is not proposed to include trees at present. These have been ably dealt with by the Arbor Society and other bodies, though perhaps sufficient emphasis from the garden point of view has not been laid on the value of many of our ornamental indigenous trees when grown as single specimens. *Pygeum africanum, Ekebergia capense, Craibea Brownii,* are instances of this.

Shrubs Suitable for the Garden

The list below contains twelve names which seem as worthy as any to make a start on.

Clerodendron myricoides is probably the best known of the local Clerodendrons. Many call it the "Blue Butterfly Bush," and it responds willingly to attention and pruning to make a show in any shrubbery. *C. ugandense* has long been known and valued in England, but it seems more insipid in colour than *C. myricoides,* and is much more dwarf in habit. *C. zambesica* makes a very handsome shrub with its large white flowers, and deserves more attention than it often gets.

Barleria Schulmannii is the only species known by name to the writer, though a very much darker blue specimen has been found this year. The shrub has a scandent habit, and comes into a mass of blue, usually at the beginning of dry weather.

Dissotis macrocarpa is probably as well known as any of the Dissotis (or wild Lasiandra), and it responds well to cultivation and makes a fine show of flower in rather moist situations. Other Dissotis deserving a place are *D. alpestris* and *D. multiflorus,* but there is still a finer species, as yet unnamed apparently, with very large pale mauve flowers, 2 in. across on bushes growing to 8 ft. It is found in the open lands and requires no extra moisture.

Dyschoriste thunbergiflora deserves every encouragement. It has the merit of covering itself with blue flowers in the middle of the dry weather when almost everything else is out of bloom. It makes a fine clump of colour and a good ornamental hedge.

Whitfieldia sp., like Dyschoriste, has the merit of flowering in the dry weather and makes a show with its plumes of white flowers. The only species found so far is near the Uganda border, but it would be interesting to know if there are not other colour varieties in the country. The plant is named after an African botanist, though the only form in culture in Europe originates from America.

Oncoba Routledgii ought to be grown more generally as a large shrub or a very effective tall hedge. Its flowers are similar in appearance to single white roses and they appear in profusion early in the wet weather.

Tinnea aethiopica always attracts attention when cultivated. It takes its place in any shrubbery, and is covered in maroon flowers for the greater part of the year. Common name, "Velvet Slippers."

Hibiscus apenurus is possibly the most attractive of the shrubby Hibiscus. In its wild state the vivid scarlet flowers are very striking, and this is only increased when plants are given the assistance of culture and pruning. Of the non-shrubby species, *H. cannabinus* should have its place in any herbaceous border, where its tall purple heads stand out with great effect.

Ruttya speciosa, or "Sealing Wax Bush," seems to adapt itself to any of our varying climatic conditions. Its fullest flowering is probably in the drier weather. Given adequate pruning, so as to overcome its natural legginess, its copper-coloured flowers, marked with black, cover the branches.

Hypericum quarternianum. Why this is not grown more it is difficult to imagine. It is a really fine species of St. John's Wort, with flowers of great size. Bushes growing to a height of 10 ft. are a mass of flower in the fall of the year.

Grewia similis, though often found in rich forest, adapts itself to poor and dry conditions with ease. Known as the "Paint Brush Flower," it is found in quantity around Nairobi as a straggling bush, but it responds well to care and pruning and is well worth its place.

Combretum paniculatum is familiar on edges of forests and in clearings where forests have been. Very similar, though perhaps even more showy, is *Combretum abbreviatum,* which is one of the sights of the road from Kenya to Jinja. It climbs over forest trees, and makes a sheet of vivid scarlet in its flowering season. In the garden it is equally striking and, with judicious pruning, may be grown as a large bush in spite of its scandent habit.

These brief descriptions cover the list of shrubs chosen for the purposes of this article. There are others which have been omitted, not because they are not equally

worthy, but only in the interests of brevity. Lists are always tiring, as much to the reader as the writer.

Before taking a haphazard list of certain herbaceous indigenous plants, there is a plant which falls into a class by itself and this is the wild banana or plantain, *Musa Livingstoniana.* For sheer effect, planted under shade or near a stream, with its lower and broken leaves well trimmed away, it is an ornament in itself. The leaves are colossal and of the freshest possible green.

Herbaceous Indigenous Plants

In this case again, a list of twelve is taken, and brevity is the only excuse for omitting many which the reader will immediately think of.

Bauhinea fassiglensis is familiar as a scandent plant along the roadsides in the western districts. Its large yellow flowers make a fine effect. If a suitable place for it to scramble over in full sun can be found in the garden, it should be put there.

Delphinium macrocentron is already famous as the "Green Delphinium." In colour it varies, probably on account of soil conditions, from a deep cobalt blue to a true sea-green. It does not like exposed conditions but prefers its roots well sheltered by surrounding plants. *D. candidum,* the white tuberous-rooted Delphinium, is perhaps less well known and undeservedly so. It is less shy of cultivation than *D. macrocentron,* and will flower freely from seed within the year. It should be remembered, however, that the plant is tuberous, and seedlings should not be disturbed until their dormant period. A third member is *D. Wellbyi,* found on our northern frontier, and this is so far comparatively little known. Its flowers vary through a range of blues and mauves, and it has the additional merit of being sweet scented. There would seem to be great chances for the hybridist with this plant.

Hebenstretia dentata is very similar to *H. comosa,* already well known in English gardens, where it was introduced from South Africa. It is found on the higher moorlands, and responds well to cultivation, where it may be grown as an annual. The plants carry long mignonette-like spikes of white flowers, throated vermilion, which are sweet scented in the evening.

Pycnostachys remontifolia is a moisture-loving species with flowers of a pure china blue. How well spread the plant is throughout the Colony the writer is not in a position to say. It is, however, a very lovely species and, if the necessary moist conditions are available, it should be given a place at once. *P. thyrsiflora* is much better known and many gardens already make use of it in quantity where-ever a good blue herbaceous plant is required. *P. Dawei* is found in Uganda, and is being introduced to the writer's garden only this year.

Thunbergia Battiscombii is another fine blue herbaceous plant of which there may be two varieties, one of which has a scandent habit. *T. Gregorii* is definitely a climber and probably the finest in that class, with rich orange, very large flowers, and most striking in full sun. *T. Gibsonii* well deserves a place, too, though it must rank below *T. Gregorii* for effect.

Acanthus emenens, the blue-flowering variety found usually in rather heavy shade at the higher altitudes, is too large a subject for a herbaceous border, but is admirably suited to the wild garden or a large shrubbery. *A. pubescens,* the pink-flowering variety, is perhaps better known and is found in more open places; whilst a white-flowering species occasionally occurs.

Aloe sp. A really fine colour effect can be made with the use of mixed Aloes in the right setting. Dry sunny banks or rocky places, where little else will grow, can be made gay with them. The writer has seen a small cliff-side filled with varying colour from yellow to scarlet just by collecting Aloes from the surrounding country.

Echinops. In certain parts of the country this dark red "thistle" is found in large numbers, and the effect is very fine. Under cultivation they do even better and their colour is a useful addition to any mixed tall border. *Echinops* sp. nr. *brevisetus* carries large heads of white flowers, and its silver foliage is an additional attraction; in habit it is much more dwarf.

Pentas coccinea has already taken its place in the gardens in Europe and well deserves it. Its rich red is an improvement on *P. carnea,* the more usual pink form. Then there is the white *P. longiflora,* very different in appearance, and most striking when planted in large clumps in the wild garden.

Vernonia uniflora is more in a class with Acanthus; too tall for the herbaceous border, but well suited for massing with tall shrubs in the wild garden. It also is at its best in the dry weather, which is an additional advantage.

Kniphofia sp. are probably best known as the "Red Hot Pokers" which fill the swamps and edges of dams in the higher altitudes of the Highlands, where they make a blaze of colour most of the year round. There are other species which are not swamp-loving, and are well adapted to the herbaceous border. *K. Snowdenii,* found on Mt. Elgon, is already in cultivation in England, where it is generally hardy. The flowers are yellow, in loose racemes, 2 to 3 ft. in height.

Coleus barbata. This is probably classed as a sub-shrub, but in cultivation it is best considered as a herbaceous perennial. It requires, however, an ample situation, and would probably be out of place in the small garden. Given a bold setting in the wild garden, it is most effective, being covered in a mass of mauve-blue spikes late in the season.

Bulbous Indigenous Plants

The following are taken for the purposes of the present article:—

Crinum Kirkii is very well known throughout the Highlands, and its appearance with the first of the rains is always welcome. Its tall, lily-like heads, striped maroon, rise to about 2 ft. The writer has seen this plant used with great effect in a wild garden setting in rough grass under trees and interplanted with *Haemanthus multiflorus,* which flowers at the same time. *C. ammocharoides* is also an up-country Crinum of a dwarf habit, very showy and responsive to cultivation. The coast species of Crinum adapts itself excellently to more temperate conditions, and its striped red and white flowers are very striking.

Gloriosa virescens should be cultivated more extensively. The weak-stemmed scandent habit usually found in the wild state disappears and the plants stand erect with all their red-striped yellow flowers well displayed. It is a much finer species than *G. superba,* which is valued so highly in Europe, *G. Rothschildiana* var. *lutea* is said to be common in some parts of the country, and in others extremely rare; it is usually found in rather dense shade in river beds, and its pure yellow flowers appear late in the season.

Gladiolus quarternianum. Every resident in Kenya notices the wild Gladiolus, and the extensive colour range that they give. Few, however, seem to appreciate

their value under cultivation, where they will grow freely in large clumps and send their flower stems up to 6 ft. and more. There should be possibilities in the hybridization of these, so as to make use of the great height in a wider colour range.

Bulbine asphodeloides is more suited to the rock garden than the open border, since it must have good drainage if it is to thrive well. It grows naturally on shallow soils surrounding rock outcrops, and its heads of yellow fluffy flowers appear early in the season. It is often found in company with *Moraea Carsoni*, and the contrast of blue and yellow is most effective.

Laperousia cruenta does not seem to be widely distributed. A bulb already popular in Europe, in appearance very similar to *Anomatheca cruenta*, but coral pink, it should be included towards the front of any bulb garden where it would take its place with ixias, freesias, etc.

Canarina Eminii ranks very high for horticultural value. It is found in open grass country, and its scandent habit enables its orange-scarlet bell-shaped flowers to appear well above the surrounding undergrowth. It should be marked down for lifting when dormant, and treated as one would a dahlia tuber. Of very different habit is *C. abyssinica*, which is found in forests, in rock crevices in big river sides; its flowers are much paler than *C. Eminii*; its habit is epiphytic, and it is often seen covering forest trees to a height of 40 ft. and more. Both species do excellently in cultivation, and both are already being grown and flowered in Europe and America.

Buphane disticha is also an early-season bulb, sending up its large pompom heads of red flowers before the large fan-like leaves. It does not seem to like the good things of life, and is usually found in rocky shallow soil in full sun. In cultivation it should be planted under similar conditions.

Haemanthus multiflorus has already been referred to jointly with *Crinum Kirkii*. It deserves every encouragement, and is already popular in other countries to which it has been sent. The scarlet pompom flowers, rising to 18 in. and more, give it the name of the "Blood Lily," and these appear early in the season with the first of the rain. *H. filiformis* is the coast species, but it accepts more temperate conditions with ease. It is smaller than *H. multiflorus*, and of a pale orange-red.

Acidanthera candida is known well near Nairobi, where it appears with the first of the rains. The pure white flowers, in appearance like Narcissus, make a lovely show in any garden, and deserve to be much more encouraged. It is not found further up-country, but bulbs moved from the Athi Plains have flowered up-country with ease. The writer has also been told of a yellow and a red flowering species, but has so far not been fortunate enough to see either. Beyond our northern frontier a blue flowering species, *A. Murielae*, is found, which has already been taken up by European growers.

Dierama cupuliflorum is a mountain lover, and is found there at 9,000 ft. and over. It accepts average garden conditions, is evergreen and free flowering. A most useful cut flower, especially in company with some of the taller South African species of Dierama or "Wind-flower."

Orchids

Before closing this article some mention must be made of the terrestial orchids, many of which can be introduced with great effect into the garden. Some of these move with ease, even in full growth,

but with others it is wiser to mark the plant down and wait until the dormant period before lifting.

Eulophia Krebsii (syn. *Lissochilus Krebsii*) and *E. bellis* are probably two of the easiest to establish in the average garden; they need little care and soon spread into an effective clump. *E. bellis* appears to be rather rare, but is well worth searching for, as its deep red on the reverse of the petals is a more striking contrast that the deep yellow and brown of *E. Krebsii*.

E. Wakefieldiana also does not seem to be found in any quantity, but this may only be a matter of finding its true habitat. The tall, pure-yellow spikes are very handsome, and it has the merit of being hardy and easy of cultivation. Very similar perhaps to *E. palustris*, but adaptable to ordinary garden conditions, not swampy ones.

Probably the finest of all our Eulophias is *E. porphyroglossus*. If you can provide even moderate swamp and shade conditions in a part of the wild garden, it must be put in there. The flower spikes rise to six or seven feet, the flowers are a rich purple, and, in a bold setting, the whole effect can be most striking. Incidentally, as cut flowers they last a good fortnight.

Eulophia subulata is a real beauty, but apparently very scarce. It is a pure daffodil yellow, rather dwarf (about 10 in.), flowers freely and for long periods in the drier weather on open plains which are inclined to be swampy in the wetter seasons of the year. If it were arranged to have *E. arenarius* and *E. subulata* flowering in juxtaposition, one would achieve a contrast of rich purple and pure yellow which no other plants could offer.

The Utilization of Sisal Waste in Java and Sumatra.—Part III

By J. E. A. DEN DOOP, *Bandoeng, Java*

In the second paragraph of the last published part of this article the author promised to "discuss his experimental and practical experience with the utilization of sisal waste, inclusive of sisal stumps, as manure, on the basis of a sufficient knowledge of the soil to which the waste was applied." This basis was discussed from its pedologic aspect and a general agricultural outline was given of the exhaustion history of the two soil types concerned. The author will now continue the outline for the red-soil type in a more detailed way, to afford some insight into the course of depletion as regards its most important food reserves and its organic matter during the progress of exhaustion.

Two soil types were discussed: first, a red soil, chiefly of volcanic origin and in its virgin state of a high, lasting fertility; second, a grey soil of sedimentary origin and in its virgin state of medium, short fertility. The waste, which comes partly from the red soil, is only applied to the grey. This part origin of the waste is not the only reason why the author paid and will pay much attention to the red soil. The chief reason is that some aspects of the red soil are better known than the corresponding aspects of the grey. The reason for this is twofold: First, when the author began in the first half of the twenties the study of these two soils, the red was available for experimentation in all sorts of exhaustion stages, whereas the grey was available only in its virgin state; second, the red soil, having developed *in situ* from volcanic mud-streams, is of a much more homogeneous nature than the grey, which is a sediment of tertiary and more recent material, and moreover encloses some small areas of red soil and over considerable areas is mixed with the latter type.

As an introduction to the detailed exhaustion history a little episode from the research history of physiologic sisal diseases may be inserted here.

In the night from the 19th to the 20th May, 1919, the volcano "Kloet" in the province Kediri of East Java ejected its crater lake together with huge masses of glowing stones, sand and ash. Boiling mud-streams descended from the volcano, killed more than 5,000 people and destroyed some 600 hectares of sisal out of the 10,000 which surrounded the Kloet on its western and northern slopes. The land not destroyed by mud-streams was covered with a layer of volcanic ash, varying in thickness from some 30 cm. to a few mm. The author, who had organized in this sisal area, during the preceding year, what was probably the first special sisal research department, had the opportunity of studying various effects of the eruption on sisal, e.g. that of the ash cover. Fig. 1 shows one of these effects.

Not only are the plants seen to be covered with ash, but in a number of the plants one observes that some of the leaves have succumbed and fallen to the ground. The cause was the development of bluish, moist, necrotic patches near the leaf bases within a few days after the eruption. Afterwards these patches dried up and became quite black.

As a phenomenon of somewhat similar appearance may be observed in sisal plants drowning in stagnant water, the possibility was suggested that oxygen deficiency might have caused this volcanic

FIG. 1
Leaf-foot disease in sisal on western slope of volcano "Kloet" after its eruption in May 1919

leaf-foot disease, the fine volcanic ash having shut off the soil pores from the air. Thus the author arranged some field experiments in which the ash-covered soil was treated in various ways with a view to facilitating air entrance into the soil. However, the result was that the number of diseased plants increased a little more in the treated than in the untreated plots. On the other hand, it soon became clear that without any treatment the number of diseased leaves in the affected plants did not increase; in fact, the plants recovered entirely. Furthermore, the appearances of newly diseased plants soon became fewer over the whole sisal area, and within half a year after the eruption no additional diseased plants were to be found. As many other urgent problems had to be investigated, this special volcanic leaf-foot disease claimed no further attention, at least for some years.

In the same year as this eruption, viz. in 1919, the Anglo-Dutch Plantations of Java, Ltd., laid out trial plots of sisal all over the vast, then still forest-clad, area on the north coast of West Java, which this company intended to develop, and one such plot was laid out in an area of red soil which until some years before had been under native crops during many decades. This latter area will further be referred to as the "old red-soil area". Three years later, when everything had already been arranged to establish two sisal estates, one in a forest-clad grey-soil area, viz. the present Soekamandi Estate, and one in the old red-soil area, it was found that a leaf-foot disease occurred in the trial plot of the latter

Dr. C. J. J. van Hall, the Director of the Institute for Plant Diseases at Buitenzorg, Java, who was the first to examine the disease, came at once to the right conclusion, that it was not an infectious one, and probably of a physiologic nature. He entrusted the author, who was then temporarily working at that research institute, with the further investigation of the disease. The author found the plants to be diseased much in a similar way as the volcanic diseased plants of three years

Fig. 2
Leaf-foot disease in sisal on badly affected patch of old red soil, within two years after planting

earlier, and concluded, after a thorough exploration of the whole area where the various sisal trial-plots were situated, that this disease was probably caused by unbalanced food conditions of the soil, on account of long-continued native cultivation without any manuring. The only advice then possible was to abandon the sisal planting in the old red-soil area, whereas no reasons could be found against the continuation of the sisal planting in the grey-soil forest area of the present Soekamandi Estate, where then already large sisal nurseries had been planted.

Some 900 hectares were planted here with sisal towards the end of 1923, and a similar area one year later. This sisal was thought to do well during its first year after planting. However, when after a trip of about a year and a half through Africa and Europe the author came back to Java towards the end of 1924, he was summoned again to this grey-soil sisal area on account of a disease, appearing here in the one-year-old sisal, and looking much like the leaf-foot disease found two years before in the old red-soil area.

The author instituted at once an extensive research of the leaf-foot disease in the grey-soil area. The diseased plants, with the exception of a few that succumbed entirely, were found to recover gradually and to resume after a period of growth stagnation a healthy growth again, just as in the case of the volcanic leaf-foot disease of 1919 in East Java. As in the latter case, too, although extended over a much longer period, the new appearances of diseased plants became rarer and rarer, until at the age of about three and a half years the 1923 sisal field was found to be

virtually free from the disease. The same story of the appearance and disappearance of the leaf-foot disease repeated itself in a similar way in each sisal field. Thus, after all, this disease was found to be not so alarming as was thought at its first appearance in the grey forest soil in 1924. However, in the trial plot of the old red-soil area the leaf-foot, which otherwise seemed much the same as that of the grey forest soil, did not disappear but grew worse year after year, not only as regards the individual plants, which finally died without having poled, but also as regards the spread of the disease over the area. Fig. 2 gives an idea of a badly affected patch of sisal less than two years old in the old red-soil area.

The serious character of the leaf-foot disease in the old red soil did not seem to have a direct bearing on the agricultural position of the sisal estate in the grey forest soil. However, the author feared, and as afterwards appeared, rightly, that the leaf-foot disease of the same destructive character as in the old red soil would make its appearance afterwards also in the grey soil when once the latter reached a certain degree of exhaustion. Thus the research of the leaf-foot disease, especially in the old red soil, was continued as far as time permitted with a view to the many other urgent problems which had to be investigated.

In 1926 a sisal selection experiment, S. 84, of the extent of about two hectares, was laid out in the old red soil with a view to investigating possible hereditary characters of sisal in connexion with leaf-foot disease. About one and a half years later the first cut was applied to this sisal. Again, about half a year later, the leaf-foot diseased plants were counted per plot of the non-selected control plants. Table I presents the data obtained.

The data of Table I prove that in S. 84 leaf-foot disease is absent in its most productive parts, whereas the other parts are the more affected the less productive they are. As it can be inferred statistically that the yields of Table I can be ascribable only to a small extent to the direct effects of leaf-foot disease on yield, it follows that leaf-foot disease in S. 84 occurs more frequently the less fertile is the soil. Furthermore, since the later yields in the cycle of S. 84, if compared with yields in fresh red soil, proved that the soil of S. 84 was rather exhausted already at planting time, it may be concluded that leaf-foot disease in the old red soil is associated with soil exhaustion.

TABLE I

LEAF-FOOT DISEASE IN CONTROL PLOTS OF S.84 AFTER FIRST CUT

Fresh leaf weight in first cut, 1½ years after planting, per plot of plants, in units of kg. ..	30	40	50	60	70	80	90	100	110	120	130	140	150	160
Percentage number of plots with leaf weights between limits as above	5	8	13	21	16	13	9	6	5	1	2	0	1	
Percentage number of plants with leaf-foot disease in corresponding plots	18	8	3	5	4	0	3	3	0	0	0	0	3	

In 1927 two lots of soil samples of the 10 cm. top layer were collected in the old red-soil area. One lot was from the old sisal trial plot, which had been planted in 1919 and in which leaf-foot disease had been discovered in 1922. The other lot was also from old red soil, which, however, had not yet, or only shortly, borne

sisal. Thus the difference in exhaustion between the two lots can be considered as equivalent to about seven years of sisal food-requirements. Plant-food estimations of these samples were made, according to methods as indicated in the note to Table III in Part I of this article, in the May, 1938, issue of this Journal. The food values of the 10 cm. top layer were computed over the 25 cm. top layer and from these soil-food data those plant-food data were subtracted which, according to plant analyses then available, are extracted from one hectare of soil by an average yearly sisal crop. The resulting figures, expressed as percentages of the soil-food data, appear as "relative food-balance figures" in Table II.

TABLE II

RELATIVE FOOD-BALANCE FIGURES

(As defined in text)

Sorts of Plant Food	In old red soil area, which bore sisal during not more than one year	In old red soil area, which bore sisal during 8 years
	Per cent	*Per cent*
N	+65	+66
P_2O_5 ..	+76	+71
CaO ..	+54	+58
MgO ..	+91	+90
K_2O ..	—19	—44

It should be clear that these data have only a certain relative value, first because they relate to the 25 cm. top layer, whereas they have been estimated in the 10 cm. top layer; second, because they do not account for the natural replenishment of plant-food reserves by internal soil activity and by rain; and third, because, as was not then but now is known, the old trial plot was situated in a place of old red soil that was rather above average quality. Thus, strictly speaking, the value of Table II lies only in the relative comparison of the figures under the one heading of soil sort with the corresponding figures under the other heading. Such comparison shows a large difference for K_2O and for this plant-food only. The conclusion is that the potassium reserves of the old red soil are depleted to a considerable extent by the requirements of seven years of sisal growing. This is, of course, only possible if in this soil the potassium reserves are small in an absolute sense, which is confirmed, although not in an absolute strict sense, by the extreme divergence of the K_2O figures in Table II as compared with the figures for the other sorts of plant-food. As it was already known that leaf-foot disease in the old red soil was associated with soil exhaustion, it had now, by the analyses just reported, become probable that this disease in the old red soil is caused by potassium deficiency of the soil.

After this discovery at once a number of sisal plants with leaf-foot disease of various extent in the old red-soil area were singly manured with amounts of sulphate of potassium varying around 200 grams per plant. It was found afterwards that all the new leaves that detached themselves from the central bud about half a year after manuring or later were quite normal and healthy. Then a similar experiment was arranged with all the eight possible combinations of nitrogen, phosphorus, potassium and unmanured. Again about half a year later it was found that in all the plants which had received potassium the leaves newly detached from the central bud were all healthy, whereas in all the other plants no influence of the manure could be detected at all.

Herewith it had been finally proved that in the old red soil the leaf-foot disease is caused by potassium deficiency of the soil, which had developed by the growing of native crops during many decades without any manure.

FIG. 3
Effect of manuring with sisal-waste ash on leaf-foot disease in sisal, grown in old red soil, as it was in S. 68 1½ years after manuring. Left side manured, right side unmanured. In manured part the disease has just begun to appear again

In the beginning of 1928, when the author already understood that leaf-foot disease in general is caused by a disturbed food-balance in the plant, but when it still had to be proved that in the old red soil such disturbance is caused by potassium deficiency, a manuring experiment with ash of sisal waste was arranged in field experiment S. 68, planted with sisal and cantala in 1925 in the old red-soil area. The idea was thus to apply manure containing all food substances, with the exception of nitrogen, that might be of importance for sisal. Quite a heavy application was made, equivalent to about 440 kg. of K_2O per hectare. About seven months after the application of this ash, which had been spread over the soil surface, S. 68 was cut for the fourth time. Some days later many of the leaves remaining on the plants became diseased in the unmanured sisal plots, whereas no disease appeared in the manured plots. Whereas since that time in the unmanured sisal plots the disease became worse and worse, the manured sisal plots remained perfectly healthy until almost a year and a half after manuring, when leaf-foot disease began to reappear. Apparently the potassium added with the ash had by then been exhausted again in some patches of the manured sisal plots. Fig. 3 shows the manure effect on sisal, as it was a year and a half after manuring, just before the sixth cut. Whereas the effect of the manure on the leaf-foot disease in sisal had been very apparent by seven months after manuring, its effect on sisal leaf production was still unnoticeable by that time; the sisal leaf crop of the fourth cut, i.e. seven months after manuring, expressed as a percentage of the crop at the third cut, i.e. six months earlier, was for the unmanured plots 67 per cent and for the manured plots 68 per cent. However, the sisal leaf crop in

Fig. 4
Effect of manuring with sisal-waste ash on sisal-leaf yield in leaf-foot diseased old red-soil area. Sixth cut in S. 68, about 1½ years after manuring. Left side manured, right side unmanured

the fifth cut, i.e. about one year after manuring, was 64 per cent of that in the fourth cut for the unmanured plots, whereas it was 111 per cent for the manured plots. This difference in sisal productivity increased further. Fig. 4 shows this difference, as a year and a half after manuring, i.e. in the fifth cut, Fig. 5 shows the corresponding difference for cantala. It will be noticed that for cantala the difference is much smaller than for sisal. Also not only was the leaf-foot disease much less serious in cantala than in sisal, but it made its appearance in the cantala plots about a year and a half later than in the sisal plots. To find out the reason for this differential behaviour some chemical analyses of sisal and cantala leaves were made, each from manured and from unmanured plots of this experiment S. 68. The percentage K_2O content in the ash appeared for cantala as well as for sisal to be nearly twice as high in the manured as in the unmanured plots; and it was found that in cantala the K_2O content in the leaf ash was only about half as high as the corresponding figures for sisal. The differential response of sisal and cantala as regards leaf-foot disease in the old red-soil area had thus been cleared up entirely.

A few months after the ash had been applied in S. 68, i.e. at a time when the leaf-foot disease still appeared unaffected by the manure, soil samples were taken from three continuous surface layers, each 10 cm. thick, from the manured as well as from the unmanured plots. At this time the area of diseased patches in the sisal plots was estimated to be about equal to that of the non-diseased patches. The methods of analysis were as in Table III of Part I of this article in the May, 1938, issue of this Journal.

Fig. 5
Effect of manuring with sisal-waste ash on cantala-leaf yield in leaf-foot diseased old red-soil area. Sixth cut in S. 68, about 1½ years after manuring. Left side manured, right side unmanured

The exchange-acidity data for the samples are presented in Table III. It will be observed from this table that the alkaline earths have not penetrated much deeper than 10 cm. Thus phosphorus and potassium have certainly not penetrated deeper into the soil. The analytical data for these two substances, and for lime, all as in the 10 cm. top layer, are presented in Table IV. The differences between the corresponding mean figures of Table IV should afford a rough measure for the food gained by the soil from the ash manuring. These differences have been transferred to Table V. The food content of the ash used, which was obtained from old partly decayed sisal waste, was 20 per cent, 5 per cent and

TABLE III

Exchange-acidity Data in S.68, Expressed in Milligram Equivalent Weights Per 100 c.c. of Soil

	Unmanured Plots			Manured Plots		
Depth in cm.	0–10	10–20	20–30	0–10	10–20	20–30
Non-diseased patches..	2·3	1·3	1·2	0·1	3·2	1·9
Diseased patches	2·5	2·2	2·8	1·1	2·7	1·0
Mean ..	2·4	1·75	2·0	0·6	2·95	1·45

TABLE IV

LIME, POTASSIUM AND PHOSPHORUS IN THE 10 CM. TOP LAYER OF S. 68, EXPRESSED IN KG. PER HA.

	Unmanured Plots			Manured Plots		
	CaO	K_2O	P_2O_5	CaO	K_2O	P_2O_5
Non-diseased Patches	1,280	470	1,780	3,320	1,050	2,400
Diseased patches	680	120	1,570	1,370	510	1,810
Mean ..	980	295	1,675	2,345	780	2,105

4.5 per cent for CaO, K_2O and P_2O_5 respectively. The amounts of food added to the soil, as according to the ash analysis, have also been presented in Table V.

TABLE V

GAIN IN SOIL FOOD BY MANURING S.68, EXPRESSED IN KG. PER HA. IN 10 CM. TOP LAYER

	CaO	K_2O	P_2O_5
Gain as per soil analyses	1,365	485	430
Gain as per ash analysis	1,760	440	396

The data for K_2O and P_2O_5 in Table V appear somewhat larger for the soil analyses than for the ash analysis. This may be due to the diseased patches having been actually somewhat larger than half the area of the plots, as was previously estimated. The lime appears to have partly penetrated into the soil somewhat deeper than 10 cm. As a whole, the data of Table V give the assurance that the analytical data as in Table IV are fairly reliable. Thus it may be inferred that in the diseased sisal patches of S. 68 in the middle of 1928, i.e. about 3½ years after planting, the exchangeable K_2O content of the soil had fallen to about 120 kg. K_2O per hectare in the 10 cm. top layer. Check analyses have shown that this figure is about 140 if in the red soil leaf-foot disease begins to make its appearance in sisal. In cantala, leaf-foot disease begins to manifest itself at an appreciably later stage of potassium exhaustion in the red soil.

It should be well understood that the given limit figures are valid only for the type of red soil under consideration. In the grey soil, for example, the author has found instances with only about 50 kg. exchangeable K_2O per hectare in the 10 cm. top layer without any leaf-foot disease occurring in the sisal on these particular places. Furthermore, it should not be forgotten that not all occurrences of leaf-foot disease are caused by an absolute potassium deficiency of the soil, as is the case with the red-soil type under consideration. Thus the author emphasizes that the inferences made should not be generalized.

The Ridge in Native Cultivation, with Special Reference to the Mwanza District

By N. V. Rounce, *C.D.A., A.I.C.T.A., and* D. Thornton, *B.Sc.,*
Department of Agriculture, Tanganyika Territory

Ridging is the most popular method of cultivation throughout the cultivation steppe of Tanganyika Territory, but in the Mwanza District of the Lake Province its adoption has become almost universal on a wide range of soils, the exception being the low-lying heavy *mbuga* lands cropped with sorghum and rice. It is estimated that ninety per cent of cultivated land in the district is ridge-cultivated; it is a system moreover which, evolved by the native, has proved to be not only of great value in controlling soil erosion but also particularly suited to crop production on the wide range of soils met with in the area. The greater part of the Mwanza District is composed of a series of hills the tops of which are granitic outcrops, and of which the soils of the lower slopes form the main cultivation area. In some parts wide valleys of *mbuga* soil separate the hills; in others they are absent. Despite the fact that the soils are sandy they quickly become saturated, and after the first few rains of the season a very considerable run-off takes place. This fact, coupled with the steep slopes of the cultivated area, has forced the native to evolve ridge cultivation, which protects his land from wash and also increases the depth of soil available to the roots of his crop plants.

The Ridge and its Formation

On the upper foot-slopes the ridges are more or less a standard size of five feet from the top of one ridge to another, while the height is approximately one and a half feet, the shape being more rounded than pointed. On the lower foot-slopes and valley margin soils a wide number of types of ridge are made, ranging from one of a similar type to those described above but larger and generally planted with cassava, to the sweet-potato ridges which are much more pointed than other types. The process of preparing a ridge (*tuta* in Kiswahili) from new uncultivated land is as follows:—

(1) The weed growth is gathered by the hoe into weed rows in the direction the ridge is to follow.

(2) The soil is then drawn up over the weed row from one side.

(3) The seed is now broadcast over the almost completely formed ridge.

(4) The cultivator then changes over to the other side and raises sufficient earth to cover the seed.

(5) The subsequent operation of weeding is undertaken a number of times and generally reduces the size of the ridge as the soil is dragged down with the weeds.

In the following years the sides of the ridges are scraped down to bring all weed growth into the furrow (*ngholowanda*), and the new ridge is formed on the site of last year's furrow. Invariably operation (2) is first completed over a considerable area, whereby the ridges are almost completely formed and it only remains to sow seed and cover it with the soil which is left over in a narrow strip from operation (2), and is just sufficient for this purpose. Before it enters the soil on the down-stroke, the long-handled hoe with a wide blade is raised well above the head, and there is little exertion entailed in the raising of the soil as it is jerked up on to the ridge by the up-stroke return

of the hoe almost as soon as it leaves the ground. All crops suited to light soils are planted on the ridge; grain and legume mixtures are broadcast, groundnuts and earth pea are planted singly by hand, either in a row on each side of the ridge on in one row along the top. Cotton is invariably planted in two rows by itself, while cassava and sweet potatoes are planted in various ways.

The Ridge as an Anti-erosion Measure

Few of the ridges run on the contour-line of the hill slopes, but they approximate very closely to it, and a big fall from one end of the plot to the other is exceptional. An immediate criticism of the ridge system as an anti-erosion measure is that every individual's field discharges into the boundary strip between the plot (which is, in effect, the end of one person's ridges and the beginning of another's) and that small gullies are formed. However, an examination of the system shows that, provided those gullies are not carrying the run-off from the bare rocky hill-tops, the individual cultivator can and does check the development of erosion in them. It is important, however, that these drainage channels should be as wide as possible, so that vegetation may grow in them. It is noticeable that the height of the ridge has tended to increase, a development which, like the evolution of the contour ridge, has taken place only in late years. It is thought that this added height has become necessary owing to the texture of the soil, which has become lighter—because continuous cultivation and erosion damage its physical properties—and possibly in order to resist the greater force of the water resultant upon reversing the direction of the ridges.

The alternative to the present system, which is very satisfactory provided that vegetation on the hill-tops is protected to prevent a rapid discharge and that grass in the drainage channels is left undisturbed, is a system of contour draining which, considering the acute and irregular slopes, would be prohibitive in time and labour. Moreover, the results would only be slightly better than those obtained by the indigenous system.

The Advantage of Ridge as Compared to Flat Cultivation

The origin of the ridge is hidden in obscurity, but it is probable that it was found to be an easy method of dealing with the weeds and not improbable that the native realized the benefits of incorporating the field refuse and weeds into the soil. Originally, before the problems of erosion and soil infertility arose, in the heyday of shifting cultivation, there is reason to expect that most of the varied methods of cultivation adopted were based initially on the easiest method of dealing with the vegetable growth. Although no experiments have been conducted on this subject in the Lake Province, at Morogoro Experiment Station some work has been done, and the results show that ridging gives better yields of maize and cotton than flat cultivation, though it must be admitted that the flat cultivation given in that part of the country hardly involves even a stirring of the soil. There is little doubt, however, that in fact, whatever the intention of the natives may have been, this practice amounts to a small application of green manure. The Territory's experiment stations have figures that indicate, but as yet do not prove, the value of this. It is probable that the process of aeration and its beneficial effect on the soil flora are the most important factors bringing about an increase in crop yields.

It would not be generalizing unduly to state that in the less specialized areas of

Tanganyika, at least, the true operation of turning over the soil is very rarely practised on a large scale on the flat. This would very nearly coincide with the European gardener's spit digging with the spade—a very arduous process. In the Eastern Province the term "flat cultivation" merely means that the weeds are skimmed off the surface and destroyed or laid as a mulch; cultivation, such as it is, is embodied in the subsequent weed-hoeing process. In some areas, especially in high-altitude *Brachystegia-Isoberlinia* country where *Eleusine* is grown, the turf-mound practice is followed, whereby the top two inches is drawn into mounds and, on rotting, is spread back over the soils. Sorghums are sown on the flat in the black clay soils of Usukuma and scuffled in, but again this does not amount to a turning over of the soil. It can thus be seen that in point of fact in Tanganyika the ridge is the simplest and the only common method of inverting the soil and aerating it in the process. The ease and speed of the work is principally dependent on the fact that actually only half the surface area is disturbed in any one year. When the furrow is formed, the soil, which under other systems would not normally be exposed to the air, undergoes oxidation. This is probably very important where the soil is not exceptionally fertile, and where erosion is taking place, particularly as this newly developed furrow soil is not used as a seed-bed for at least two years, until, with an extra deep blow of the hoe, when the ridge is split, it is incorporated into the soil of which the ridge is actually composed.

The ridging system also, of course, facilitates the turning-in of manure and does not require the dressing of all the surface area in the one year. Unknowingly, the cultivator spaces his crops automatically by planting only on the ridge and allowing room for inter-cultivation. An improvement in the system, which might be introduced if it did not involve so much extra work, would be a light digging of the furrow bottom before it is covered by a weed row and ridged over. As regards water retention and resistance to drought, the ridged compares very favourably with the flat surface. The surface area is increased and should actually absorb more water. Results of experiments at Mpwapwa Veterinary Research Laboratories, where the downhill ridge was found to lead to less run-off than cultivation on the flat, bear this out. During drought the soil seems to pack less, and certainly no evidence has been presented to prove its undesirability under severe dry conditions. Its value for drainage purposes needs no emphasis.

Over a series of years it has been found in Usukuma that the average time taken by one man to re-ridge one acre of medium-texture ridged land is fifteen eight-hour days, whilst one acre of black clay sorghum land scuffled and sown on the flat takes nine days.

Possibilities of Extension to Other Areas

The factors, other than the human, controlling extension of this system are as follows:—

(1) Quantity of grass and weeds to be disposed of beneath the ridge.

(2) Texture of the soil.

(3) Climate, particularly rainfall.

In high-rainfall areas the soil is often so fertile and loose that no preparation of the soil is undertaken previous to planting. In any case, it is not yet known with certainty whether this would be beneficial. In dry-forest areas, however, it is thought that it would be, particularly

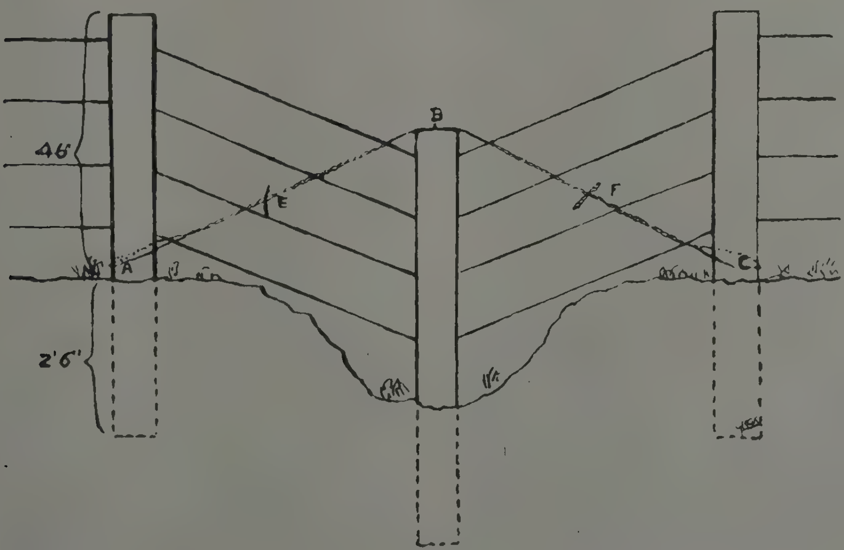
in the first years of cultivation after bush clearing; for it has been shown at Kingolwira Station that under these conditions stirring of the soil considerably increases the yields of grain crops. Comparison for different tribes between the work done and time involved may be invidious owing to their different characteristics and physique, but it is worthy of mention that an average of thirteen eight-hour days was recorded in Morogoro District as the time taken to prepare and plant one acre of land on the flat for either grains, cotton or groundnuts. As described previously in another section of this article, the ridging operation, where admittedly fewer weeds had to be disposed of, took only two days more. In conclusion, it is considered that this practice might well be experimented with in other areas, and that it has not as yet received the attention it deserves.

A Note on Fencing Across Small Ditches

By C. A. THORNTON, *Njoro, Kenya Colony*

In the recent excellent articles on farm fencing I did not notice a method of fencing across small ditches. The appended figure shows one method which I have tried successfully.

After placing in position the post in the ditch, a double wire is stretched from A to B to C and is kept in place by a small notch at B. This wire is now made tight at E and F by twisting with small sticks. The post in the ditch must of course be wired in position before the other fencing is erected.



The Usefulness of Entomological Collections in Agricultural Institutions

By T. H. C. TAYLOR, *D.Sc., Entomologist, Department of Agriculture, Uganda*

Entomologists engaged in economic work are frequently asked why it is that they often devote part of their time to amassing large collections of insects, many of which are of little or no economic importance. This is an important question, since it raises the further question as to whether economic entomologists should be encouraged to undertake, as part of their official duties, what is usually known as "general collecting," i.e. the collection of all sorts of insects found in the field and the subsequent preserving, labelling, arranging and cataloguing of them so that they are always readily available for reference.

The collector of insects is commonly known as a "bug-hunter," and he is pictured in *Punch* as a bearded, spectacled gentleman who races across the countryside with a butterfly-net. He is popularly regarded as a man whose one object is to amass a huge collection of insects with pins stuck through their middles, and many people find difficulty in understanding how his activities can be of any use to the economic entomologist. The uneducated African goes so far as to believe that a European who collects insects must do so either to eat or to sell them.

Many economic entomologists undertake general collecting as a hobby, and some of those who belong to this class may be accused of devoting too much time to their hobby, to the detriment of their investigations of insect pests; in extreme cases, this criticism is undoubtedly reasonable. Other economic entomologists make no special efforts to collect insects other than those which are directly connected with the particular problems which they are studying, but they nevertheless capture or preserve many other insects which come their way; in this case, the collection ultimately formed may be almost as large as that acquired in a shorter time by more assiduous collectors, but the proportion of time devoted to collecting is comparatively small. Other economic entomologists, again, have no interest whatever in general collecting and confine their attention entirely to those insects which may be regarded as pests or to those which affect such pests.

It is necessary, at the outset, to distinguish between the mere amassing of adult specimens of insects and what may be termed intelligent collecting. The difference is best explained by examples. One man goes to a certain locality, sees a certain insect which he has never found before, catches it, takes it home, puts a pin through it, and adds it to his collection. There the matter ends. He is pleased to have added another specimen to his collection, but he has learned nothing. Another man goes to the same locality and sees another specimen of the same species. He also catches it with a view to preserving it, but before leaving the locality he examines the plant on which he found the insect and notices a number of eggs on the leaves. He collects the eggs, and possibly other immature stages. He also notes (in addition to the locality and the time of year) the name of the plant, the part of the plant on which there is evidence of the insect having been feeding, and anything else likely to be of interest. Some days later the eggs hatch and he feeds the resulting larvæ on the same plant. He describes or sketches the

larvæ. Eventually these individuals become adult and are added to the collection, and he finds that they belong to the same species as the original specimen. He now knows, not only the adult insect, but also the eggs and the developmental stages. This is intelligent collecting. Much information has been obtained, and although it is often impossible to obtain as much as this, the attempt can always be made. In general, intelligent collecting may be said to include the recording of any characteristic habits and ecological preferences (e.g. degree of shade, concealment, moisture, succulence of tissues). From the economic entomologist's point of view it is important that particular attention should be paid to the insect fauna of wild plants allied to crops grown or likely to be grown, and that insects related to known pests should be collected and studied as opportunity permits, especially with a view to obtaining a knowledge of their parasites and food plants.

The insect collection of the Department of Agriculture, Uganda, will serve very well as an example of the sort of collection which results from general collecting by economic entomologists. In the writer's experience, it is exceptionally extensive, well kept, and well arranged, for an agricultural institution in the tropics. It was commenced about 1909 and has been built up by a succession of officers, and others outside the Department of Agriculture, who represent, between them, all classes of collectors; and it now consists of approximately 30,000 specimens of Uganda insects representing some 6,000 named species, stored in 40 cabinets containing 570 drawers. The orders Coleoptera, Orthoptera, Hemiptera, Diptera, and Lepidoptera are very extensively represented, but all other orders of insects are included also. Species which are definitely known to be pests form only a very small proportion of the collection. Every specimen is fully labelled with date, locality, and collector's name; and the reference number of the species to which each specimen belongs is also written on the label. Only named species are now put in the collection. For very many species considerable information, besides that which normally appears on the labels, is available, and these species are all catalogued. At least one page is allotted in the catalogues to each species, and all information regarding distribution, food, habits, development, parasites, etc., in Uganda, is recorded. References to literature are also included. Further, the early stages of many species are illustrated by coloured drawings executed by Africans trained for the purpose. The collection is constantly growing as new species are discovered, and new entries are constantly being made in the catalogues as further information becomes available. The economic entomologists concerned familiarize themselves, by means of the collection, with the general insect fauna of the territory in which they operate. It is at once obvious that much time is required in the aggregate for the building up and maintenance of a collection of this kind, and we can now proceed to consider to what extent economic entomologists are justified in thus occupying part of their time.

We may first take a simple hypothetical example to illustrate the general usefulness of the collection. An officer is instructed to study an insect which has just reached Uganda from a neighbouring country, and which is well known as a pest in that country. He collects specimens, labels them in the usual way, and goes to place them in the collection for reference. On pulling out the appropriate drawer he finds that several other closely

allied and very similar species, indigenous to Uganda, are already in the collection. He at once refers to the catalogue, and learns that all the indigenous species have been obtained from plants of one family only, and he concludes that the alternative food-plants of the introduced species also are likely to be confined to that family. He also learns that the early stages of all the indigenous species are so similar that he cannot rely on reports of the occurrence of the new arrival in various parts of Uganda unless he actually sees the specimens on which the reports are based. He notices that all the specimens of the indigenous species have been obtained only in the drier areas of Uganda, and he concludes that the new species will probably be troublesome only in those areas. In the catalogue he finds records of several parasites which have been observed to attack the indigenous species and he considers whether they could be utilized in any way for the control of the new arrival should it become a pest. Specimens of the parasites in another section of the collection are then examined, and in the appropriate catalogue volume he learns that they attack a great variety of insects and concludes that for this reason they are unlikely to be of much economic value.

The entomologist concerned obtains all this information, and much more besides, from the collection in a short time. It helps him considerably in drawing up his initial programme of work, suggesting, as it does, several lines of investigation which might not otherwise have occurred to him until a much later stage in his work. In other words, the presence in the collection of certain species which are of no economic importance whatever and which were obtained, perhaps many years previously, in the course of general collecting and without direct economic motive, proves to be of practical value.

Intelligent collecting of insects in the field, together with the study of a collection which already exists, provides the collector with a clear idea of the ecology of the country in which he works, and this is obviously essential if insect problems are to be approached, and investigations carried through, in a rational manner and with the right perspective. He gets to know the plants from which he collects and records insects and thus gradually acquires a knowledge of the flora and fauna of the different climatic zones and soils of his territory. Moreover, he cannot obtain a sufficiently thorough knowledge of any insect pest without collecting and studying to some extent those other insects which are related to it and especially those which live in association with it in the various ecological areas.

The introduction of beneficial insects often necessitates an extensive knowledge of the insect fauna already existing in the country into which the beneficial species are to be introduced. Without such knowledge, which can be obtained only by general collecting, there is a risk of time and money being wasted in introducing species which are already present but have not attracted attention because they are rare and confined to wild plants. Instances of this are known. Also, the attempt to prevent the introduction of harmful insects into any country from other territories is comparatively futile unless the insect fauna of that country is already well known.

Another important purpose served by general collecting is that it enables entomologists to recognize insects which are suspected as potential pests because they attack wild plants closely allied to cultivated plants. For example, an insect which normally feeds only on wild plants of the family Malvaceae, and is unknown as a pest, may attack cotton when the

latter is extensively cultivated in the area in which the insect occurs; and it is of great advantage to entomologists studying cotton insects to know the fauna of the family Malvaceae in general. Similarly, general collecting in forests may lead to the presence, in collections, of insects which, perhaps many years later, are found attacking coffee, in which case details as to wild food-plants, distribution and other useful matters are at once obtainable from the collection.

The collection is useful, not only to those who are actually responsible for it, but also to many others whose interests or work bring them into contact with insects. Insects found by agricultural officers, planters, gardeners, and others on their crops, garden plants, animals, or even on human beings, are sent to economic entomologists with the request that information may be supplied concerning their habits and the likelihood of their becoming pests. Often the insects sent are comparative rarities. The entomologists can identify them by means of the collection and can judge what the species to which they belong are likely to do. Again, workers in other countries may want to introduce into their countries beneficial insects (usually parasites or predators) to control pests. Such workers are greatly benefited if they can be provided with information relating to useful insects occurring elsewhere.

The educational value of a general collection in an agricultural institution is considerable in areas where museum collections are not yet available. The collection stimulates and sustains the interest of those whose hobby is natural history and encourages voluntary workers to make observations (supported by specimens) which are useful not only to themselves but also to the economic entomologist. The work of the latter is often restricted to one particular ecological area or to certain times of the year when some species of insects are not common enough to be in evidence, and in such cases co-operation with voluntary workers is most desirable and is of mutual benefit. The collection and the catalogued records which supplement it are also useful for demonstrations to classes of students of biology.

There is one other useful result of general collecting which warrants special mention. The Imperial Institute of Entomology, which is very closely associated with the Department of Entomology of the British Museum, renders great assistance to entomologists in departments of agriculture in a variety of ways, not the least of which is the study, from the systematic point of view, and the naming, of insects found attacking economic plants, as well as the very large number of insects which are not at present known to be of any economic importance. Much time is spent by workers at the British Museum in this way and much of this work is of little benefit to those who do it, since almost all the specimens obtained from economic plants are of species which are already represented in the British Museum. But the consignments of insect specimens sent by a department of agriculture in which general collecting is encouraged commonly include many species which were not previously represented, or are poorly represented, in the British Museum, and such specimens are appreciated by both the Imperial Institute of Entomology and the Museum and are retained to enrich the national collections. In this way it is possible for economic entomologists to make some return to the Institute, other than the annual monetary contribution, for the valuable services which they receive from it. It is not suggested that a primary function of economic entomologists should be collecting

insects for the British Museum, but it is pleasant to reflect that they can benefit the Museum, as well as themselves and their official work, by general collecting.

It has always been the policy of the Entomological Section, Uganda, to encourage general collecting within reasonable limits, and to recognize it as an important, though not a major, part of the work of all officers of the section. Expeditions solely for the purpose of general collecting must obviously be made, if at all, in spare time, but much useful collecting can be done, and is done, on economic plants, on plants allied to them, and on neighbouring plants in the course of official duties and in official time. If officers are prepared to undertake collecting of a more general nature also in their spare time, so much the better. The soundness of the policy of encouraging economic entomologists to undertake general collecting is sufficiently evident from the few examples cited in this article. The writer has worked in countries where general collections are either non-existent or scanty and is now in a position to say that economic entomologists in those countries are at a great disadvantage as compared with those of a country like Uganda, possessing a collection which, though necessarily very far from complete, is nevertheless already sufficiently comprehensive to provide valuable information on most of the problems which arise in the course of the work of the economic entomologists concerned. The proportion of an officer's time which can suitably be devoted to the collection and the study of insects in general is a matter which must be decided by the officer himself as a rule, or, in extreme cases, by the Senior Entomologist. Investigations of immediate economic value must obviously take precedence, but the economic entomologist who excludes from his activities the collection and study of insects in general must inevitably approach his particular problems with an exceedingly narrow outlook, and is of less economic value to his employers than one who regards these activities as an essential, but secondary, part of his work.

Derris Cuttings

It is expected that in the course of this year a quantity of *Derris elliptica* cuttings of high-rotenone strain will become available for distribution from the East African Agricultural Research Station, Amani. The price will be, as for previous years' distributions, 5 cents a cutting (unrooted), plus Sh. 5 per 1,000 for packing and transport to the Muhesa railway station and plus onward rail charges. Application should be made, without remittance in the first instance, to territorial Directors of Agriculture, through whom the available supplies will be allocated.

Food Shortage Periods in Native Reserves

By W. LYNE WATT, *M.B.E., Cert. H.A.S., Senior Agricultural Officer, Kenya Colony*

To those who are directly interested in the well-being of the African in his own country, those times when it is inevitable that a large proportion of the population must suffer from shortage of food give cause for great anxiety. These periods of food shortage can be due to a multitude of causes, such as locust invasion, drought or flooding, low prices for cash crops, which cause a lack of confidence amongst the producers, land destruction by erosion, over-population, and so on. The complete apathy of the native cultivator who is directly affected by such shortages engenders a feeling of helplessness in those who are acquainted with the conditions under which food supplies are produced. Food shortage can be prevented or reduced in so many ways that it is in theory a danger which could be overcome in a few years. This is not the case, however, and it will take many years to educate the mass of the rising generation of native cultivators to think not only of to-day, but of to-morrow and of next year. Efforts to prevent famine should embrace methods which will give cultivators a chance to protect themselves from themselves, and be accompanied by repeated vocal and practical demonstration of every means at our disposal.

Much has been written and said in recent years on the dangers to be feared if we fail to care for our soil as a primary duty. It is not only foolish, but criminal, for a tribe to play with its greatest asset, and if this is realized then this cause of danger can be left out of the present article. Locust invasions are inevitable, but not frequent, and cause the destruction of many crops, including the grass which produces the milk and meat. Droughts and floods can almost be treated as one, since they both reduce the bearing capacity of the land. Much can be done to overcome their danger by soil treatment, or the selection of suitable crops.

Not all cash crops can be eaten, but if a cash crop will grow better than the usual food crops of a particular district, why waste time and takes chances by pinning one's faith to the less trustworthy. It may be a hot area, liable to periods of dry weather, which would cause less hurt to a crop of cotton than of a cereal. It may be an area liable to flooding, which, while a source of real danger to the favourite millet crops, is yet able to give the desired stimulus to rice. In East Africa millets can rarely be sold to an outside market, but rice can be used by all communities. When a district is suitable for the growing of some form of produce which can be marketed and turned into cash, the grower in that district has the power to save or "store" hard cash against difficult times, and cash has a far better keeping value than, say, sorghum grain in a dirty and weevily store. This method of "food storage" is not recommended as one to be followed implicitly by all, but it is an alternative, and it obviates the danger of death from disease which is present when a large proportion of the African's wealth is stored in the form of live stock. One might argue that cash in the bank would be in danger should war break out; but the cattle of any owner is in an equally precarious position.

There are the two main types of agricultural country which influence one's choice of action, viz. the one-season or

one-crop-per-year type and the two-season or two-crops-per-year type. In country where only one crop is grown each year there is each year a great likelihood of food shortage before the harvest is in. The two-season type of climate invariably encourages a larger population, which results in only small areas being available for each family, and, in consequence, here again one can find, under average conditions, that there are amongst the primitive unguided people certain deficiencies, particularly in extremely dense populations where grazing is scarce. The administrative and agricultural worker in native countries must, if he is to guard his apathetic and primitive charges, keep a strict eye on them, otherwise sooner or later the inevitable period of difficulty will come. It has been noticed time and again that whenever a period of good rains or good prices comes, the African promptly forgets the past hardships. Precautions against shortage may have been taken, even if too late, but he rapidly forgets the new methods. There have been famines and periods of poor prices in the past, and nothing is more certain than that they are liable to return in the future, and while this is so we must be prepared. We have the means to guard these people from unnecessary hardships, and although in the case of extreme drought or locust invasion it may not be possible to prevent hardship completely, it should be possible to steer safely through fairly adverse periods.

Cash-saving facilities should be given at all big money or selling centres, even though their provision should result in a small loss for some years. There is a fair scattering of post offices throughout East Africa which could do much more for the native than simply handle letters. They could be utilized for the control of portable savings bank units, which could tour the big money centres on fixed days. If that were impracticable, these sub-offices might be kept open for savings bank business during the months when produce is being sold. A bank of a different nature, in the form of working power, could be used while men are fit. They could plant trees which would complete their growth in the days of the workers' frailty. Trees have usually a good market value and can be bought, cut down, and removed by the buyers.

Crop selection is the usual means for preventing famine, and can aim at the production of a long-lived drought-resister, a quick-growing catch crop or a crop which will store well. For the first, cassava is ideal and is a real gift in native country having the type of climate which suits the sweet potato. Mango fruit is a good food and can be dried for keeping purposes. Catch crops may be early-maturing varieties of sorghum or eleusine millet, tepary bean, buckwheat or pearl millet. For good storing qualities nothing will beat eleusine millet and rice. The introduction of early varieties of crops would seem to be an easy matter after they have been proved to be suitable for the area in which it is intended that they should be introduced. It might be expected that an early, high-yielding crop of palatable foodstuff would be keenly sought after and cared for by the natives, but it is not; and one sees these early crops being eaten by the birds while the hungry growers are lazing about and doing nothing to protect the useful seed. In the early days of such a new crop it is essential to place a good proportion of the harvest in storage for the next season, but this is not the rule, as the harvest generally comes when the stores are empty, so the owners eat the lot while waiting for their main crops to ripen, thus depriving themselves of a useful aid against future

adverse conditions. In the case of an early and dwarf variety of sorghum which has been found useful in the Nyanza Province of Kenya, it has been possible, in an adverse year, to reap a crop of five bags per acre before the drought set in that reduced the main sorghum crop to some two bags per acre; then, from the ratoon crop, to harvest eight bags per acre, making a total of thirteen bags of grain in seven months, against the main crop of only two bags. In spite of this gift, the natives still allow the out-of-season crop to be damaged by birds.

To overcome these dangers, particularly in the year of issue, it is advisable to keep back the seed of the new crop for as long after the main crop is sown as the difference in maturing period of the two crops, so that the early crop will mature at the same time as the late crop and will suffer little damage from birds. In the second and succeeding years the natives should be advised to plant the early low grower in mixture with the later high-growing sorghum or maize, which to a great extent will cause it to be sheltered from birds.

Notes on Feeds and Feeding

By M. HALCROW, *B.Sc. Agric. (Edin.), Dip. Agric. (Cantab.), A.I.C.T.A., Agricultural Officer, Department of Agriculture, Kenya Colony*

At this time of year there is a tremendous variation in the feeding position from farm to farm. The fortunate farmers have no doubt heaved their sighs of relief on the appearance of the first rains while many are still in the throes of the annual contest with the dry season. Fortunately, however, the result of the struggle is nowadays less in the lap of the gods than formerly. The provision of dams and improved watering facilities generally, combined with the storage of hay and ensilage, have contributed much to safeguarding the stock-farmers against drought.

The importance of adequate drinking water for the dairy herd is generally appreciated but there are very few farmers who give the matter the attention it deserves. It would be interesting to know what percentage of the falling-off in milk yield that is usually attributed to the "dry season" is in reality due to inadequate drinking facilities. A cow loses water in the form of milk, in the urine and droppings, in breathing and sweating, and the daily total must be considerable. The water is derived from all that is taken in by way of the mouth, either as food or drink, and also from the breakdown of certain constituents of the animal body, particularly the fat. Not a little of the "slimming" that one occasionally sees on stock farms during the dry season can be attributed to the using up of fat in the production of metabolic water. The hump of the native ox, like that of the camel, is Nature's "drinking bowl" in times of drought. One might argue perhaps that since the fat makes up for any deficiencies in the watering facilities there is no need to worry. The price, however, that an animal pays for the use of its fat is a lowering of its production, whether of beef or milk, and afterwards a gradual lowering of its vitality and well-being. In such a case it requires a long time to recover.

In practice in this country, where succulent rations are conspicuous by their absence, a fattening steer has a water requirement of 7 to 10 gallons, depending

on the succulence of the grazing. Working oxen and cows in milk require correspondingly more than this amount, while young growing calves have relatively higher requirements in proportion to their live weight. A rough formula for cattle is three parts by weight of water for each part by weight of dry matter consumed. It has been proved best to give water little and often. This is well brought out by American figures, which show that good cows, supplied with water whenever they felt like it, produced 4 per cent more milk than similar cows watered twice a day, and 6 to 11 per cent more than cows watered only once.

Mention has been made of the comparative absence of succulent feeds in this country. It is, however, comforting to see that a very real attempt is being made to overcome this difficulty by the provision of ensilage. Well-made silage comes into its own at this time of year, for not only is it useful in the absence of grazing due to a prolonged dry season, but it has the added advantage of reducing the chances of cattle being "blown" when new grass is coming away. This trouble is prevalent at the end of March and the beginning of April, particularly on Kikuyu grass at the higher altitudes, and no better preventive need be sought than to continue with the dry-season ration of ensilage, and possibly rather less, for a few weeks into the rains. If a cow does get blown, a tablespoonful of turpentine in half a bottle of linseed oil will usually effect a cure.

With the advent of the rains and the rapid growth of the grass it is usual for farmers on the more intensive systems to cut down their rations almost immediately, especially in respect of the high-protein constituents. This is a short-sighted policy for several reasons. In the first place the young grass coming away so quickly rarely possesses the high feeding value popularly attributed to it. Rather does it act as a milk stimulant at first. It is best therefore, particularly where good grade cows are concerned, to continue with the rations for a short time into the rains and to reduce gradually if it is felt that the total feed is in excess of that required for maximum production.

It is true that young grass is high in protein and that the sooner the feeding of expensive high-protein foods can be dispensed with the more chance there is of showing a profit, but it must be remembered that in the production of butterfat protein is a most important item; it affects the rate of secretion more than any other single factor. It is better to risk feeding a little too much at first than the reverse, because if the ration happens to be slightly deficient in this constituent the percentage of butterfat in the milk will tend to fall. Cows should be forced to the utmost of their capacity, and when their maximum output has been discovered the rations should be reduced to the minimum required to keep them in good condition at that rate of production.

A Non-parasitic Disease of Arabica Coffee

By G. B. WALLACE, *B.Sc. Agric., Ph.D. (Edin.), Plant Pathologist, Department of Agriculture, Tanganyika Territory*

The disease of coffee described below is characterized by certain unusual symptoms in the bark and wood, and results in the death of trees. That the explanation offered to account for it is the correct one has not yet been proved, but it is sufficiently plausible to warrant this brief account. The trouble was referred to in the Annual Report for 1936 of the Department of Agriculture, Tanganyika Territory.

OCCURRENCE

The diseased coffee trees are growing on native plots at an elevation of about 4,400 ft. on the western slopes of Kilimanjaro. Climatic and other factors are favourable for coffee culture. The trouble was first observed in 1936 by Mr. L. F. Higgens, Agricultural Assistant, who realized its unusual features and brought it to the attention of the laboratory. It had been known for about four years to the local natives, and examination of diseased wood indicates that it had commenced not long before.

All the affected trees are over five years old; on the plot examined in some detail the trees are thirteen years old. On the same ground are a few two-year-old replants which are healthy.

The soil of these plots is deep and red, and deficient in humus. It packs rather hard and cracks in dry periods. No manuring is done and cultivation has not been a very regular practice; the ground is much trodden. Shade is afforded by bananas and a few local trees. The general appearance of one plot in particular indicates carelessness regarding the cultural requirements of the trees.

SYMPTOMS

Trees in various stages of health and disease are to be seen. The best are not really good, but in November, 1938, they still bore a small amount of old leaf and had borne a small crop. There was a certain amount of new leaf growth. Other trees bear few branches, small amounts of leaf and negligible crop. The worst trees are almost devoid of leaf and bear no crop. Trees die and are cut down each year.

Attention is called to some of the trees by their bare and dead branches. Closer examination reveals canker-like symptoms on the main stem where the primary branches arise and on these where secondaries originate. The bark at these parts is characteristically very rough and loose and readily flakes off in parts (Fig. 1). On removal of this bark the affected part is seen to be flat or slightly sunken. Here and there the wood is exposed. On the main stem the upper parts are the most affected.

Sections through diseased parts of stem and branches show long or short arcs of very dark tissue in the outer rings (Figs. 2 and 3). These arcs are not necessarily on the same radii. Such diseased arcs within the wood have usually become healed over by callus tissue, but cases were seen where the affected parts had not healed and these remained exposed and flat.

In parts of the diseased bark can be seen thin wafers of a pure white colour. When picked out this white substance crumbles to a fine dust. This was believed to be calcium oxalate, and an ample quantity was readily obtained for analysis. Mr. H. B. Stent, Chemist at the Coffee

FIG. 1
Part of main stem of a coffee tree showing cankered appearance and rough loose bark

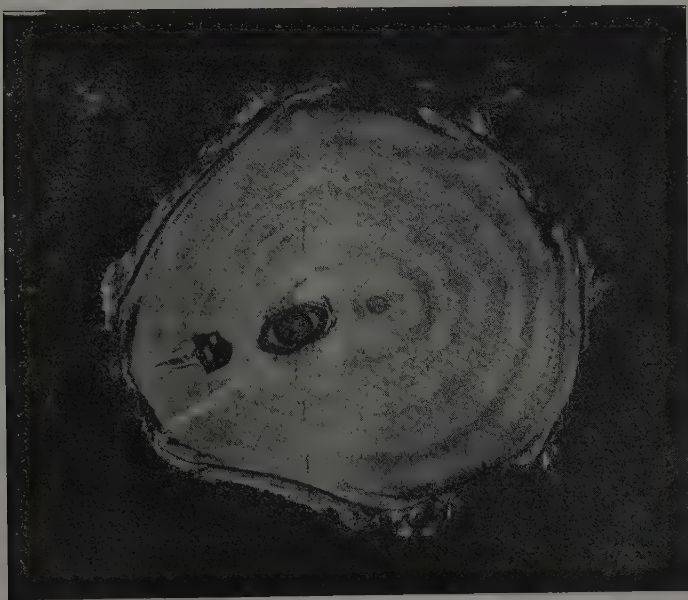


FIG. 2
Section of a coffee stem showing diseased arcs partially callused over

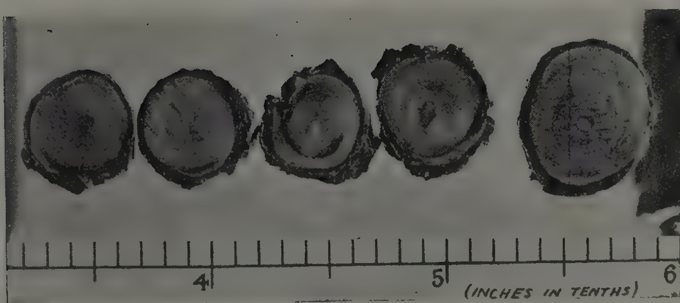


FIG. 3
Sections of small branches showing diseased arcs callused over

Research Station, made the necessary analysis and has provided sufficient evidence to confirm the nature of this white crystalline substance as calcium oxalate.

Cause of the Disease

Previous examination has shown no insect which could account for the trouble, though its superficial resemblance to gnarled stem canker of tea and similar diseases in other trees which are caused by insects suggested that possibility. Microscopic examination revealed no fungus in the tissues of wood or bark.

The probable explanation of the disease requires no supposition of parasites, but was indicated by a closer study of the history and environment of individual trees. It was learned that, instead of being planted in large holes, the seedlings had been pushed into small holes made with a stick. Examination of a number of dead stumps and living trees showed that the stems were buried to a depth of six inches. The roots were twisted and curled and had not managed to spread out. The soil being naturally liable to pack, insufficient cultivation and frequent treading had aggravated the condition. The result has been that the trees have been almost starved. The presence of callus over old necrotic areas indicates that at certain times some more favourable factor has operated, such as a fall of rain, cultivation, more active nitrification, etc. But the cankering recommences before long. At the present time there are few parts of the stems which have not been injured.

Control

The affected plots require very thorough renovation. A few trees will be left to see if they will respond to improvement in their environment, and to cleaning up the trees by pruning off dead twigs and removing dead bark and lichen.

The majority of the trees and all the old stumps will be taken up and the land properly cultivated, and later manured. Strong seedlings will be planted at the correct depth in filled-in pits. It is expected that by these methods a stand of healthy trees will be obtained and that this disease will not again be in evidence.

INTERNATIONAL BIBLIOGRAPHY OF AGRICULTURAL ECONOMICS

The International Institute of Agriculture in Rome has now begun to publish a current bibliography, at quarterly intervals, which will deal with agricultural economics in all its various phases. This bibliography will be based on the material received by the Library of the Institute and continues the *Internationale Bibliographie des Agrarökonomischen Schrifttums* which was started in 1933 and included in the journal *Berichte über Landwirtschaft*, published under the auspices of the German Ministry of Agriculture.

The scope of the bibliography covers the economic and social aspects of agriculture, such as agricultural economics, agricultural policy, settlement, credit, cooperation, insurance, marketing, prices, statistics, farm organization and management, valuation, labour, accounting, and closely allied subjects such as rural sociology, agricultural history and geography, legislation and education. Titles of all publications, whether books and pamphlets or articles in periodicals, are given, and all bibliographical details required for proper identification. All languages receive equal treatment, and titles in the less known languages are provided with a translation.

The bibliography, which is the only one which covers systematically the world literature on agricultural economics, is carefully classified by subjects. An author-index will be supplied at the end of each volume. The annual subscription, postage included, is 7/- or $ 1.60.

The Mountain Pawpaw

(*Carica candamarcensis*)

By L. A. ELMER, *Assistant Agricultural Officer, Kenya Colony*

As many people do not know this easily grown fruit and some who know it do not know how to use it, the following note may be of use in making it popular. It should be borne in mind that it is a fruit which should be cooked. A case is known to the writer where trees in bearing have been rooted out because their owner disliked the fruits. He had tried eating them raw; later, eating the cooked fruits, he regretted not having learnt how they should be prepared.

The Mountain Pawpaw is a native of Columbia and Ecuador, where it grows at elevations up to 8,000 ft. or 9,000 ft. It grows easily in East Africa and begins to fruit lavishly at from twelve to twenty months from the time of planting, depending on the altitude, soil, etc. At 6,000 ft. it has been known to bear in twelve months.

It is similar to the ordinary pawpaw but the leaves are smaller and darker. The fruits are about 4 in. long and when ripe they turn the familiar orange-yellow in colour and fall. If picked just before they turn completely yellow they will keep for several days and stand a long journey.

The spacing recommended is 6 ft. × 6 ft. In suitable weather a few seeds can be planted at stake in the orchard or plants can be raised in banana-leaf pots and be planted out when 3 in. to 4 in. high. Care must be taken that seedlings are not allowed to grow up close together or weak plants will be obtained.

It is suggested that a few trees be planted every year to give a succession. The life of the tree is not known yet but trees five years old are in existence.

It is probable that if left to grow much older they will become too tall for the fruits to be gathered easily.

RECIPE FOR STEWING

Take ripe fruits and wipe them. Peel the skins thinly, cut open and remove the seeds. Slice into quarters. To six or seven fruits add the juice and grated rind, but not the white pith, of one lemon, add sugar to taste. Cover with water and stew gently until soft. Slow, thorough cooking is necessary to develop the flavour which is reminiscent of stewed apples and peaches.

No one in East Africa appears to have made preserves from the fruit yet. The following recipe comes from Ceylon:—

PAWPAW JAM

Choose fruit three-quarters ripe; remove all skin and seeds; chop the fruit into small pieces. Weigh, add an equal weight of sugar, also some green ginger (cut into small slices), 2 oz. of the latter being sufficient for 6 lb. of fruit. Cover up the fruit and sugar, and let the latter dissolve during the night. Boil the next morning until done.

Pollution of Streams by Coffee Effluent*

INTERIM REPORT BY COFFEE POLLUTION COMMITTEE (KENYA COLONY)

The object of this investigation was to see what could be done to prevent the tainting of water with coffee effluents, and to prevent any danger of coffee itself, washed lower down the stream, from acquiring a tainted flavour.

1. (i) In November, 1935, the Water Board asked the Senior Agricultural Chemist and the Hydrographic Surveyor to investigate complaints of the pollution of streams in the coffee areas and to report on the subject.

(ii) In June, 1936, the Water Board considered their report and with the cooperation of the Coffee Board decided to appoint a Committee to examine means of preventing pollution of streams by coffee effluent. The Committee was also asked to make recommendations on the quantity of water required to pulp and wash coffee. As it was realized that the Committee's recommendations could not be expected for some time, the Water Board issued a circular stating the precautions which should be taken by planters to prevent unnecessary pollution in the meanwhile.

(iii) In June, 1937, the Soil Chemist submitted to the Committee a report dealing with the laboratory work done on this subject. This investigation showed that the major part of fresh coffee factory effluents consisted of sugar in solution. It was shown that chemical coagulation and centrifuging was only able to remove about a quarter of the whole, the remaining three-fourths, amounting to about 500 lb. of effluent dry matter per ton of clean coffee, being present in solution and therefore not amenable to removal by any coagulation and filtration methods. This would necessitate additional biological filter beds for the purification of this large amount of non-coagulant source of pollution. Such a double plant would involve relatively large capital expenditure and subsequent running costs owing to the relatively large amounts of chemical coagulants required, and therefore such a method of preventing the pollution of streams could not be recommended. The use of earth seepage pits for the thick first and second tank washings was recommended as a first cheap and simple method of reducing pollution. The Committee asked the Hydraulic Engineer of the P.W.D. and the Soil Chemist to proceed with a proper field and laboratory survey of the pollution problem.

2. An inspection of coffee factories was carried out and eventually four were chosen for observation (referred to in this report as A, B, C and D). These, it was considered, would give the varying conditions required, such as difference in the quantity of water available, difference in the size and quantity of machinery used in the coffee factory, difference in the method of treatment and washing of the coffee, and difference in the situation and soil of the seepage pits.

3. This preliminary investigation and subsequent inspection of many coffee factories showed that pollution was divided into two heads:—

(*a*) The pollution caused by the drainage through and seepage back to the river from the decomposing pulp heaps. This is more or less continuous during day and night during the whole picking season.

(*b*) The pollution caused by the addition of solid matter to the various effluents produced by the pulping and washing of coffee. This is found in—

(i) The pulp-carrying water.

(ii) The effluents from the main, repasser and lights tanks during pulping.

(iii) The drainage from the above tanks after pulping has ceased.

* Reprinted from the *Monthly Bulletin of the Coffee Board of Kenya*, Vol. V, No. 49, 1939, pp. 12–15.

(iv) The first and second washings carried out in the tanks.

(v) The channel washing and grading.

The whole of these are only effective during the hours that pulping and/or washing are being carried out.

4. (i) Pollution of this nature (para. 3 (*a*)) from decomposing pulp heaps is often caused by incorrect siting of the pulp separator, in that the pulp is not thrown clear of the return water channel, and incorrect siting of the pulp dumps. It is also obvious that inefficient separators which allow pulp to return with the pulp water are an added cause.

(ii) A good type of separator has a cone or double inclined planes of coffee wire, the pulp water falling vertically through the wire into a concrete collecting box and thence being piped away for a sufficient distance to clear the contaminated area. This separator should be so sited that the pulp can be moved daily across the slope and the whole of the area thus contaminated protected by a surface drain leading to a seepage pit.

This source of pollution has only been mentioned briefly because it is easily preventable and can be dealt with by the vigorous application of Rule No. 133 of the Water Ordinance Rules, 1935. It must, however, be emphasized that pollution of this nature is very general, is continuous, and is evident even on some estates that have taken quite a lot of trouble in dealing with their pulp. When it is considered that the large majority of estates have done little to improve this side of their factory, it is not unfair to assume that from 40 to 50 per cent of the river pollution is caused by drainage from decomposing pulp.

5. *The pollution caused during the process of pulping and washing coffee (para.* 3 (*b*) *above).*—The main investigation carried out at the coffee factories was designed to measure the amount of pollution occurring in each of the various divisions of the water used in the factory. To this end accurate measurement of the water flowing in each pipe or channel was made and representative samples of each were analysed at the Scott Agricultural Laboratory. As this involved much routine laboratory work and much replication of samples at the factory was necessary, a specially delicate hydrometer was constructed. This was tested out with pure sugar solution and later with standard effluent solutions. It was thus possible to obtain fairly accurate information of the varying waste matter content of different factory flows at the factory. These values were checked by gravimetric analysis of selected samples and found to give very close agreement. The values quoted in this report are averages of numerous determinations. The results are tabulated below:—

TABLE I

POLLUTION EXPRESSED IN TERMS OF DRY MATTER CONTENT TO THE WATER USED

Operation	Factory				Mean
	A	B	C	D	
Pulping—	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Pulp-carrying water	0·50	0·34	0·655	0·384	0·470
Main tank effluent	0·75	1·00	0·91	0·90	0·89
Repasser and/or lights tank effluent ..	0·54	0·39	—	0·15	0·27
Washing—					
1st washing water	1·00	1·00	0·992	1·210	1·05
2nd washing water	0·60	0·51	0·26	0·471	0·46
3rd washing water	0·10	—	0·15	—	0·125
Repasser water	—	0·50	—	—	—

From Table I it will be seen that the most highly polluted effluent is the first washing water, and that this is closely followed by the effluent from the main coffee tank during pulping. The second washing water and the pulp-carrying water are only half as highly polluted as the bean-carrying water.

TABLE II

POLLUTION EXPRESSED IN TERMS OF WEIGHT OF MATTER ADDED TO THE WATER PER TON OF CLEAN COFFEE TREATED

Operation	Factory				Average	Percentage of average total
	A	B	C	D		
	lb.	lb.	lb.	lb.	lb.	Per cent
Pulping—						
Pulp-carrying water	357	277	395	407	359	56·5
Main tank effluent	136	202	95·8	231	166	26·0
Repasser and/or lights tank effluent	16·3	62	—	42·7	30·25	4·8
Washing—						
1st washing water	34·4	55·3	103·2	30·5	55·8	8·8
2nd washing water	25·6	18·0	15·8	13·2	18·1	2·8
3rd washing water	17·1	—	9·5	—	4·45	0·7
1st repasser water	—	11·0	—	—	2·75	0·4
	586·4	625·3	619·3	724·4	636·35	100·0

These figures demonstrate the largeness of, and the small variation in, the total waste matter reaching the stream under average crop conditions from factories widely varying in design.

Obviously the main conclusion drawn from the above table is that the pollution arising from pulping operations, amounting as it does to 87.3 per cent of the total, is much more serious than that arising from coffee washing, and that the proposal to dispose of the initial washing waters in seepage pits is not going to alleviate appreciably the pollution problem. The effluents from the washing tanks have been decaying for from twelve to forty-eight hours in the coffee tank and are in a highly objectionable state when returned to the river.

Attempts were made to carry out experiments in the laboratory to decide how long effluents diluted with river water took to become objectionable. It was not possible to decide on any fixed standards of measuring the degree of pollution. This can only be expressed in general terms, thus: The undiluted washing water was "sour" at time of sampling, was slightly "foul" after one day and "very foul" after two days. When diluted with nine parts of water it became "foul" after five days. The undiluted pulp-carrying water became slightly sour after three days, and when similarly diluted it became more sour than foul even after six days.

The bean-carrying water became "slightly foul" after four days, and the diluted material became more sour than foul but less so than the pulp-carrying water after six days. Determinations of the reaction values of the undiluted and diluted solutions did not show any marked differences. The washing water was initially the most acid, but on standing all samples approached the same more acid condition.

TABLE III

COMPARING PERCENTAGE POLLUTION WITH QUANTITIES OF WATER USED

Operation	Water Used (Taken from Table 6)		Pollution (From Table 2)
	Gal./ton clean coffee	*Per*	*Per*
Pulping			
Pulp-carrying water	7,982	36·5	56·5
Main tank effluent..	1,867	8·5	26·0
Repasser and/or lights tank effluent	1,866	8·5	4·8
Washing			
1st washing water..	548	2·5	8·8
2nd washing water..	398	1·8	2·8
3rd washing channel washing and grading	7,435	33·9	0·7
Repasser or lights washing.. ..	1,820	8·3	0·4
TOTALS ..	21,916	100·00	100·00

Table III enables a comparison to be made between loss of water and removal of pollution by the seepage pit method. The following figures (Table IV) deal only with pollution occurring at the factory and do not take into account the anticipated 40 to 50 per cent improvement by dealing with the pulp dump.

TABLE IV

RELATION BETWEEN POLLUTION REMOVAL AND LOSS OF WATER

Effluents disposed of in seepage pits	Percentage removal of pollution	Percentage loss of water
	Per cent	*Per cent*
1. 1st washing water ..	8·8	2·5
2. 1st and 2nd washing waters	11·6	4·3
3. 1st and 2nd washing waters and main tank effluent ..	37·6	12·8
4. 1st and 2nd washing waters, main tank effluent and repasser tank effluent ..	42·4	21·2

No. 3 above is the most economical result. On the majority of estates the amount of coffee passing through the repasser is small in comparison with the water used and therefore the pollution factor of the repasser tank effluent is low. But it is usually the case that the main tank effluent and the repasser tank effluent flow in the same channel and therefore structural alterations to the factory would be necessary to put No. 3 into operation. Failing that No. 4 would have to be adopted, but this entails an unnecessary loss of water.

Summarizing sections 5 and 6, it is believed that a very great improvement, amounting to the removal of 40 to 50 per cent of the present pollution can be made by the proper control of pulp dumps.

Regarding factory effluent it is believed that 37.6 per cent of the polluting matter can be removed by passing 12.8 per cent of the factory water into seepage pits. This leaves 62.4 per cent of the factory-produced pollution carried by the remaining 87.2 per cent of the water. Of this amount 56.5 per cent of the polluting matter is carried by the 36.5 per cent pulp water, which is too large a quantity for seepage-pit treatment.

This pulp water, after passing through the separator, contains a certain amount of solid matter in suspension which could be removed by sand filters or by rapid percolation through gravel or broken stone beds near the river, but the quantities of water are so large as to make it difficult to recommend anything of this nature. As this would only remove the matter in suspension it does not seem to be an economical solution, and instead plain settlement pits have been suggested.

Experiments on the effect of fermented dilute effluents upon the quality of coffee have been conducted, but the results were

most inconclusive. A further series of experiments has been designed, the results of which will be submitted later.

6. *Situation of Pulp Separator.*—During the investigations at the factories it was found that the situation of the pulp separator had a very direct bearing on the quantity of polluting matter added to the pulp-carrying water.

In the tables given in section 6 the samples of pulp-carrying water were taken as near to the pulper as possible. It was found that water carrying pulp along a channel rapidly leached out more soluble matter, and the following result, taken at a factory where the pulp water was checked by baffles and stirred by boys with rakes shows how quickly the water dissolved the sugar in the pulp:—

TABLE V

Position of Sampling	Pounds of sugar in water per ton of clean coffee
Abour 20 yards from pulper	407 lb.
About 40 yards from pulper	721 lb.
About 60 yards from pulper	827 lb.

Admittedly this result was produced by the fact that the pulp was held in the channel and continually stirred, but it does show the effect of carrying pulp long distances before separating.

A similar result was obtained in another way in the case of a factory which had no repasser and where the screen rejects were continually returned and put through the pulper again. This increased the pollution in the pulp water, and the result can be seen in Table I, factory C.

It may therefore be taken that a very potential source of extra pollution lies in the siting of the separator at any distance over 100 feet from the pulpers, and while the conditions given in section 5 have still to be maintained, planters should be obliged to separate the pulp from the pulp-water at within 100 feet of the pulpers. In some cases this will necessitate the re-design of factories.

7. *Quantity of Water used for Treatment of Coffee.*

It will be seen that there is no great difference in the amount of water used in factories A, B and D, which are all of the more modern type using repassers, swirls, etc., and having extra water introduced at various parts of the process. Factory C is of the old type, consisting of a single pulper pulping all the coffee into one tank and taking the whole of its water supply through the pulper. As there are still many of this type of factory on the small estates the proportion of one to three is probably nearly correct and the mean figure gives a good average. Factory D may be taken as a maximum having a very large water supply.

It will also be noted that factory C, having all its coffee (first, seconds and lights) in one tank, uses much more water for its first and second washings than the others. It has no washing channel and the separation of its lights and skins is done in the tank.

The type of factory is very well defined by the ratio which the pulp-carrying water bears to the total water used in pulping. The percentage in the present cases is:—

Factory ..	A	B	C	D
Percentage ..	68%	61%	85%	66%

The three factories A, B and D will have to be supplied with greater seepage pit capacity to deal with the larger tank effluents.

8. *Seepage Pits.*—Seepage pits were provided and recorded at each factory. During the observations a period of heavy rainfall occurred which made the test more severe.

TABLE VI

AMOUNT OF WATER USED IN GALLONS PER TON OF CLEAN COFFEE

OPERATION	FACTORY				MEAN
	A Pumped from river	B Long furrow from river	C Short furrow from dam	D Large furrow from large river	
	Gal.	*Gal.*	*Gal.*	*Gal.*	*Gal.*
Pulping—					
Pulp-carrying water	7,140	8,140	6,040	10,608	7,982
Main tank water	1,810	2,022	1,053	2,572	1,867
Repasser and/or lights tank water.. ..	1,485	3,132	—	2,846	1,866
Total for pulping operations	—	—	—	—	11,715
Washing—					
1st washing water	344	553	1,042	253	548
2nd washing water	426	300	606	258	398
3rd washing water and channel washing and grading	7,180	7,264	5,425	9,890	7,435
2nd coffee washing and grading	2,370	2,412	—	2,500	1,820
Totals	20,755	23,823	14,166	28,927	—
Total for washing operations ..	—	—	—	—	10,201
GRAND TOTAL	—	—	—	—	21,916

C=Type of factory likely to be replaced.

TABLE VII

	FACTORY SEEPAGE PITS			
FACTORY..	A	B	C	D
SITUATION OF PITS				
Height above stream	120 ft.	20 ft.	3 ft.	100 ft.
Distance from stream	900 ft.	60 ft.	75 ft.	600 ft.
Nature of soil	Deep red	Deep red on steep slope	Dark alluvium with high water table	Deep red
Capacity of pits	7 pits 240 c.ft. each and 6 pits 170 c.ft. each	Various	1 pit 600 c. ft. capacity	7 pits 288 c. ft. capacity each
Totals ..	2,700 c.ft.	1,800 c.ft.	600 c.ft.	1,916 c.ft.
Average daily pick at peak period ..	3½ tons	3 tons	·4 ton	3 tons
Amount of effluent of first two washings to be disposed of daily	630 c.ft.	658 c.ft.	176 c.ft.	342 c.ft.
Percentage of total capacity ..	23	37	30	18
Success or otherwise	Successfully disposed of effluent including wet period	Pit space being increased during observations	Insufficient	Entirely successful

It will be appreciated that the efficiency of seepage pits depends on the situation and type of soil. Factory C was specially included to test the efficiency of a pit in alluvium having a very small head. Unfortunately space was limited and only one pit could be dug.

General conclusions may be drawn as follows:—

(*a*) In the deep red soil on which most of the Kiambu and Kabete factories are situated the washing waters can be disposed of by supplying pit space five times the capacity of the daily wash water bulk. For a factory dealing with an average peak pick of one ton of clean coffee the washing waters will be 950 gallons (Table VI) or 150 cu. ft. The total pit capacity would then be 750 cu. ft. If, as was done on two factories, seven pits each of the daily capacity are constructed, then each pit is only filled once a week. This gives the residue time to dry, and it can be stripped off leaving a clean pit ready for use.

(*b*) Factories situated on the bank of the stream, in valleys and on the edge of alluvial flats cannot expect to deal with their effluent with the same capacity pits as those mentioned above, and in a really bad situation two weeks will be required to seep the daily effluent. This will necessitate fourteen pits of peak-load washing-water bulk to ensure dealing with the effluent in wet weather. If the situation does not provide room for these pits it will be necessary to pump the effluent up to a red soil area when the capacity required becomes the same as in (*a*).

(*c*) If the suggestion to include tank effluent in the seepage pits is adopted the pit capacity will require enlarging.

(*d*) Factories situated on rock with no room for seepage pits must pump their effluent.

An experiment carried out at factory A gave the following result: The effluent from the main and lights tanks during pulping was run into a fairly clean pit of 240 cubic feet capacity. Pulping continued for 108 minutes and during this time 1,995.9 gallons were disposed of in the pit.

Effluent added	Pit space occupied
Cu. ft.	*Cu. ft.*
35·2	Nil
63·9	16·8
90·0	32·1
171·6	99·3
319·8	163·3

The pit immediately absorbed the first 35.2 cubic feet and only required 163 cubic feet to take charge of 320 cubic feet of effluent. Being a fresh solution of sugar and water, percolation was very rapid and in twenty-four hours the pit was ready for use again. It is reasonable to double this result as a factor of safety, and allow total pit capacity equal to daily effluent capacity in deep red soil. In the case stated in para. 8 (*a*) above this would necessitate enlarging each of the seven 150 cubic feet capacity pits to 235 cubic feet. This will deal with the washing and effluent waters effectively.

9. *Time Lost in Tanks Draining.*—In connexion with the advocated method of dealing with the first two washing waters in the coffee tank before admitting the coffee to the washing channel, doubt has been expressed that the time taken to effectively drain off the effluents would seriously interfere with factory procedure during the rush period. Observations were made at each factory and the results are as follows:—

TABLE VIII

	Factory A	Factory B	Factory C	Factory D	Mean
Coffee in tank (tons)	·66	1·30	·37	·63	·74
Drainage time (minutes)—					
1st washing	11	24	25	17	19
2nd washing	19	20	9	32	20
TOTAL	—	—	—	—	39

Draining time includes the time from the opening of the sluice to the opening of the cock for the addition of the next lot of washing water.

10. Owing to the unseasonable rain, the flood condition of the rivers and the number of springs in operation no conclusive results were obtained on the following line of investigation:—

Determination by chemical and physical analysis of effluent and of water at selected points along a stream of the purifying (or otherwise) value of a section ($1\frac{1}{2}$ to 2 miles in length) of native reserve between two coffee areas.

11. All the chemical and analytical work in connexion with these investigations was carried out by Mr. G. H. Gethin Jones, M.Sc., Soil Chemist, Scott Agricultural Laboratories, and the field measurements by Mr. H. E. Carrick, B.Sc., Assistant Engineer, Public Works Department.

12. The Committee make the following observations and recommendations:—

(i) The Committee considers that pollution likely to be harmful to coffee under treatment, to domestic supplies and to animals occurs when the effluent from pulp dumps, from tanks during the pulping process and from the first and second washings are returned direct to the river.

(ii) The Committee considers that pollution caused by the return of pulp-carrying water to the stream can be greatly lessened by placing the pulp separator in close proximity to the pulper.

(iii) The Committee retains an open mind on the question of the likelihood of the remaining washing waters and the pulp-carrying water when diluted being injurious to coffee under treatment.

(iv) The Committee, bearing in mind that no great loss can be permitted in the majority of rivers, considers that the maximum steps which can be recommended at the present time to deal with coffee factory effluents consist of putting the main tank and the first and second washing effluents into seepage pits and quick separation of the pulp. These measures will reduce the pollution of streams considerably.

(v) The Committee considers that up to 20,000 gallons of water are required in the preparation of a ton of clean coffee. It therefore recommends to the Water Board:—

(1) Vigorous enforcement of Rule 133.

(2) The pulp separator shall not be further away from the pulper than 100 feet unless specifically endorsed on the licence or sanction.

(3) There shall be no surface flow or drainage from pulp dumps into the stream.

(4) That several pits, of such size as to reduce the velocity of the water, to enable any solid matter in it to settle out, be constructed along the channel conveying the water from the pulp separator to the streams and that the sediment from such pits be removed daily.

(5) The effluent from the first and second washings and the main tank effluent be diverted into seepage pits.

(6) The seepage pits shall be of sufficient size to deal with peak flow. There shall also be no direct surface flow from the seepage pits to the stream.

(7) That further work be carried out on the effluents and streams.

(8) That the Water Board approach the Medical Department for its co-operation regarding the hygienic condition of streams polluted by coffee effluents.

Vernonia subuligera as a Green Manure

By R. J. M. SWYNNERTON, *B.A., Dip. Agric., A.I.C.T.A., Agricultural Officer, Tanganyika Territory*

In the greater part of the West Usambara plateau, at 4,000 feet and over, the Wasambaa do not plant their main crops with the long rains in March and April, as is done in the southern foothills and plains, because they would develop in the cold spell from June onwards. Nor can they follow the practice in the northern section of the mountains and plant with the short rains of October and November, because they are scanty at these heights and are usually followed by a very dry spell in January and February. Instead, they utilize the showers that occur in August, and the crops, developing slowly in these cold areas, also get the benefit of the short rains. These August showers are known locally as the *mlwati* (Kisambaa) rains, and correspond to the *mchoo* rains on the coast. They are heralded by the flowering of the *mlwati* (Kisambaa) tree, a species of *Dombeya*, whose white flowers are a feature of the countryside at that time of the year.

Throughout these mountains the shrub *Vernonia subuligera* (*tugutu* in Kisambaa) grows profusely and forms a great attraction for butterflies and other insects when in flower. When cultivating their maize plots the natives in these *mlwati* rain areas cut back the Vernonia shrubs to within a foot or eighteen inches of the ground and incorporate their heavy tobacco-like leaves into the soil, a form of green manuring which has been in practice for many years. Where the Vernonia is not present in sufficient quantities, it is customary to plant cuttings at irregular intervals, usually from two to five yards apart. During the life of the maize crop the stumps shoot out again and are allowed to grow until the following season, when the practice is repeated. Not only is this beneficial in providing organic matter but it assists in holding up the soil on the steep slopes common to this area. By itself, however, this method of green manuring is not sufficient to replenish the soil reserves removed by the maize crop and by erosion, so that, while it may increase the cropping life of a piece of ground, it does not allow of continuous cultivation. After two to four years of cropping, the land has to be rested and the cultivation shifted to another site for a similar period.

Throughout the Western Usambaras the natives are tackling erosion by laying the annual weeds in rows along the contours when the lands are cultivated and by planting contour hedges to support these rows. Among the plants advocated for hedge planting is this *Vernonia subuligera*, and by this means it may continue to be employed as a green manure, but in a more orderly fashion.

Analyses of Some Tropical Foods

A recent *Tropical Agriculturist* (Vol. 90, pp. 3-29, 1938) contains a large number of analyses of Ceylon argricultural and horticultural products. The tables below give those which refer to plants grown in East Africa. There is no doubt that such knowledge of the chemical composition of locally grown foods is of the greatest importance for any attempt to improve diets. Moreover, as Dr. Joachim remarks in a prefatory note, although there is some local variation in the composition of any specific plant product, especially in the mineral constituents, the variations are such as would permit of the use of analyses obtained in one country for the planning of diets in another without any serious likelihood of error.

In connexion with these analyses, Mr. N. V. Rounce remarks:—

"Attention might well be paid to the distribution of seed of the Drumstick tree, *Moringa oleifera* (*M. pterygosperma*), often found growing in the compounds of Indians in East Africa, who attach great importance to the value of its pods and leaves as vegetables and to its roots as a flavouring similar to horseradish. It is an easily grown tree, is attractive in appearance, and grows well at low and medium elevations to 5,000 feet. Inquiries might be made as to its palatability to natives, as it will be noted from the table that the protein content of its fruit and leaves is very high indeed."

TABLE I.—ANALYSES OF CEYLON FOODSTUFFS

Name	Botanical Name	Moisture	Protein	Carbo-hydrate	Ether Extract (Fat)	Fibre	Mineral Matter	Calorific Value per 100 gm.
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Calories*
Cereals—								
Rice (polished) ..	*Oryza sativa* ..	13·24	6·31	78·14	0·38	0·33	1·60	341·2
Kurakkan corocan ..	*Eleusine coracana*	12·36	7·61	74·76	1·35	1·57	2·35	341·6
Maize	*Zea mays*	12·81	7·20	73·76	3·99	1·20	1·04	359·8
Guinea corn	*Sorghum vulgare* ..	9·38	7·57	74·93	3·92	1·31	2·89	365·3
Bulrush millet	*Pennisetum scrobiculatum* ..	12·29	7·54	68·60	3·37	5·31	2·89	335·0
Pulses—								
Green gram	*Phaseolus aureus*	12·08	21·70	57·70	0·96	3·33	4·23	326·2
Black gram (husked) ..	*Phaseolus mungo*	13·41	22·99	59·42	1·12	0·01	3·05	339·7
Cowpeas	*Vigna unguiculata*	10·88	26·82	52·35	1·10	4·94	3·91	326·6
Soy bean	*Glycine hispida* ..	13·02	37·01	27·89	14·23	2·90	4·95	387·7
Oil seeds and products—								
Cashew nuts	*Anacardium occidentale* ..	5·43	18·60	38·10	35·15	0·31	2·41	543·2
Roots and root products—								
Manioc (cassava) ..	*Manihot utilissima*	67·83	0·81	29·63	0·58	0·71	0·44	127·0
Manioc flour	.. ..	12·90	2·18	80·24	1·58	1·91	1·91	343·9
Sweet potato	*Ipomœa batatas* ..	81·01	1·40	15·99	0·22	0·17	1·21	71·5

TABLE II.—LEAFY CEYLON VEGETABLES (KNOWN TO GROW IN TANGANYIKA)

Name	Botanical Name	Moisture	Protein	Ether extract	Carbo-hydrate	Fibre	Mineral matter	Calcium	Phosphorus	Iron mgm per 100 gm.	Calorific Value per 100 gm.
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per ceht*	*Per cent*	*Per cent*		*Calories*
Amarantus sp.	*Amarantus viridis* ..	87·45	3·46	0·18	4·97	1·31	2·63	0·295	0·070	6·30	35·3
Drumstick ..	*Moringa oleifera* ..	77·12	8·05	0·92	10·66	1·01	2·24	0·387	0·075	5·20	82·9

TABLE III.—OTHER GREEN CEYLON VEGETABLES (KNOWN TO GROW IN TANGANYIKA)

Name	Botanical Name	Moisture	Protein	Ether Extract	Carbo-hydrates	Fibre	Mineral Matter	Calorific Value per 100 gm.
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Calories*
Brinjal	*Solanum melongena* ..	90·51	1·03	0·15	6·09	1·63	0·59	29·8
Red pumpkin ..	*Cucurbita maxima* ..	92·76	1·00	0·14	4·64	0·83	0·63	23·8
Ash pumpkin ..	*Benincasa hispida* ..	96·74	0·25	0·07	1·87	0·73	0·34	9·1
Cucumber ..	*Cucumis sativus* ..	96·92	0·42	0·02	1·98	0·40	0·26	9·8
Cowpea	*Vigna unguiculata* ..	88·34	2·86	0·04	6·89	1·26	0·61	39·4
Beans	*Phaseolus vulgaris* ..	88·82	1·40	0·10	7·28	1·46	0·94	35·6
Drumstick ..	*Moringa oleifera*	89·30	2·21	0·11	4·54	2·89	0·95	34·7
Ladies finger ..	*Hibiscus esculentus* ..	91·82	0·94	0·07	5·42	0·99	0·76	26·1
Breadfruit ..	*Artocarpus communis* ..	73·70	1·94	0·51	21·95	1·11	0·79	100·0

TABLE IV.—VITAMIN C CONTENT OF CEYLON FRUITS

Name	Vitamin C (Ascorbic Acid) Mgs. per 100 gm. or 100 c.c.	
Guava	127	Large country variety ; numerous seeds.
Papaw	61	
Orange	57	Very sweet Vavuniya fruit.
Orange	49·3	Navel orange from Peradeniya.
Grapefruit	48	Marsh's seedless variety from Peradeniya.
Mandarin	45	Well matured, sweet, Peradeniya.
Pummelo	41	Well matured from Colombo.
Lemon	37	From Peradeniya.
Lime	31	British Guiana variety from Peradeniya.
Seedless lime	28	
Mango varieties av.	43	Ambalavi from Jaffna.
Hog plum	42	*Spondias mangifera.*
Tomato	27	Large variety.
Tomato	15	Local small variety.
Tree tomato	11	*Cyphomandra betacea.*
Soursop	15	*Annona muricata.*
Custard apple	16	*Annona squamosa.*
Pineapple	14·5	Local Mauritius variety.
Young coco-nut	3·1	Pulp.
Young coco-nut	1·5	Water.
Plantain	1·3–2	Ripe ; *embul hondarawela, puvalu* and *kolikuttu* varieties.
Sugar cane	0·36	
Pomegranate	0·2	Fruit not fresh.
Avocado pear	Trace	

Notes on Animal Diseases

Compiled by the Department of Veterinary Services, Kenya Colony

II—EAST COAST FEVER AND RELATED DISEASES

East Coast Fever

East Coast fever is a disease of cattle caused by the small protozoan parasite *Theileria parva.* The multiplying stages of this parasite, "Koch's blue bodies," are found in one of the types of white cells (lymphocytes) in the spleen, lymph glands, kidneys and other organs. These stages are occasionally found in the lymphocytes in the blood. The red cells of the blood usually contain other stages of the parasite, known as small piroplasms.

East Coast fever received its name from the fact that the disease was first recognized in cattle introduced into Rhodesia through Beira in 1901.

Methods of Infection.—East Coast fever is non-contagious. In nature the disease is always transmitted by the bites of infective ticks. Experimentally it can be reproduced by the inoculation of spleen pulp and blood taken from an animal reacting to the disease.

Incubation Period.—The incubation period varies from 6 to 25 days, the average period being about 13 days. The duration of illness is from 6 to 20 days (usually about 8 days) from the first rise in temperature. Under ranching conditions animals may be noticed to be sick only two to three days prior to death. In cases which end fatally, death usually occurs from 20 to 25 days after exposure to the bites of infected ticks.

Symptoms.—Apart from the rise in temperature, early symptoms are not very marked. The animal may be somewhat listless and tend to lag behind the herd. As the animal continues to feed until the disease is well advanced the illness may pass unnoticed by the native herdsman. The most characteristic symptom is swelling of the lymphatic glands; the superficial glands beneath the ears, in the hollow in front of the shoulder and in the fold of skin in front of the stifle become prominent. In the later stages œdema of the lungs causes a marked disturbance in respiration. Finally the animal becomes weak, lies down and rises with difficulty or not at all.

Cattle suffering from East Coast fever frequently relapse to redwater, and in such cases the symptoms of the latter disease are superimposed on those of the former.

In a certain percentage of cases the eyes are affected. A whitish film appears on the surface of the eyeball and blindness results. In cases which recover, the animal regains its sight.

Mortality in adult animals introduced from "clean" areas to highly infected areas may reach 95 per cent. When outbreaks occur in clean areas, however, a high percentage of recoveries is sometimes reported. Such outbreaks may appear so unusual that the true nature of the disease is not suspected. The animals are sick for a few days only, enlargement of the glands is not marked, and may pass unnoticed; in fact, careful examination may reveal that only one superficial gland is slightly swollen. In such cases small piroplasms may be rare in the blood and Koch's bodies may be concentrated in one lymphatic gland. Prolonged searching of a routine gland smear may fail to establish the presence of parasites, although the appearance of the cells in the smear may suggest that the case is one of East Coast fever.

Post-mortem Lesions.—In cases from an enzootic area a diagnosis can often be

made from the appearance of the organs after death. It is necessary to stress, however, that in sporadic cases from clean areas the classical lesions are often absent.

In typical cases the lungs are markedly œdematous and hyperæmic. When incised, a frothy, yellowish fluid exudes from the cut surface. Froth may be found in the windpipe and at the nose. When the lungs are thus affected some yellow fluid is usually present in the chest cavity. The heart may show hæmorrhages under the membrane lining the left ventricle.

The fourth stomach is frequently congested and discrete ulcers, usually black in colour, and angular in shape, may be present. The intestines may be congested and may show scattered hæmorrhages. Lines of hæmorrhages are often present in the rectum. Lesions in the intestines are often lacking in calves.

The liver is usually enlarged, and mottled and pale in colour. The gall-bladder is usually distended with thick bile. When a breakdown to redwater has occurred the liver is often yellow or orange in colour and, of course, lesions of that disease may be present in other organs.

The spleen may be slightly enlarged, but is not markedly thickened or greatly increased in size unless the case is complicated with redwater.

In typical cases, in adult cattle from highly infected areas, the kidneys show "infarcts", reddish or pale yellowish-white spots varying in size from that of a pinhead to that of a small pea. When near the surface these "infarcts" are seen projecting slightly from the surface of the kidney after the capsule of the kidney has been stripped. Typical "infarcts" are rarely seen in cases from clean areas.

The lymphatic glands are swollen and on section the cut surface is very moist; indeed an excess of fluid usually escapes.

Transmission.—The most important transmitter of East Coast fever is the brown tick, *Rhipicephalus appendiculatus*. The black-pitted tick, *R. simus*, the Cape brown tick, *R. capensis*, and the red-legged tick, *R. evertsi*, were shown experimentally to be capable of transmitting infection during the early years of the century and until recently it was thought that transmission was restricted to species of this genus. In 1937, however, Fotheringham and Lewis showed at Kabete that certain species of *Hyalomma* could also carry infection.

Infection does not pass through the egg of the tick. Larvæ become infected through feeding on an infected animal and after moulting the nymphæ are infective. Similarly nymphæ may pick up infection to transfer to a new animal as adults. If infective nymphæ feed on an immune animal or an insusceptible species, the infection is lost and the moulted adults are clean.

Although a number of different species of ticks are known to be capable of transmitting East Coast fever under laboratory conditions, experience has shown that under natural conditions the brown tick is of far greater importance than the others. About 1911 the Colony of Kenya was divided into the present "clean" and "dirty" areas, and it is now realized that the "clean" areas are, on the whole, areas in which the brown tick does not thrive. Isolated islands where conditions for this tick are more favourable occur in the "clean" areas, and in such islands the control of East Coast fever is always more difficult.

A point of importance in the transmission of East Coast fever is the fact that an infected adult tick can transmit the disease only after it has fed on a beast for a period of not less than sixty hours. An infected tick removed or accidentally detached during the first five days after

commencing to feed, should it become attached to another host, is still capable of producing the disease.

Animals Susceptible.—East Coast fever is a disease of cattle only. All attempts to infect other domesticated and game animals have failed. At Kabete several attempts have been made to infect buffalo. On the last occasion (1931) a buffalo calf about one month old, caught in a "clean" area, was infected heavily on the ears with ticks of a batch the infectivity of which had been proved. No temperature reaction ensued, nor did daily examination of blood and gland smears reveal the presence of parasites. Later the calf was placed in a highly infected camp for two days. After removal the calf was kept under observation but neither clinical examination nor smears gave evidence of infection having occurred.

Although animals other than cattle cannot develop East Coast fever, it is possible, though unlikely, that they may play a minor role in the spread of the disease. There is always the risk that infective ticks, either unfed or that have not fed for more than five days, may be brushed off immune cattle, game or even off natives' blankets to complete their meal on a new host.

Immunity.—East Coast fever is almost unique among protozoan diseases in that the majority of adult animals that recover from a natural attack of the disease develop a strong and durable immunity. When, exceptionally, a second infection is contracted the reaction is not severe. In calves, it is probable that a considerable percentage are liable to undergo a second, milder infection, and it has been suggested that young calves in enzootic areas suffer from repeated, almost continuous, attacks of the disease for a period of several weeks.

The fact that animals born and reared in enzootic areas have a strong immunity, together with the fact that such animals are incapable of infecting ticks, has made possible the use of "T" cattle in Kenya. Cattle from enzootic areas are exposed for six weeks in a heavily infected testing *boma*. Those that survive are branded "T" or "LT", and such cattle are permitted to move between clean and East Coast fever infected areas.

Treatment.—No substance of plant origin nor any chemical preparation has been found effective in the treatment of East Coast fever. The search for a cure is being continued, the vast majority of new chemo-therapeutic preparations being tested in one or other of the veterinary laboratories in Africa.

Preventive Measures.—The only way of controlling East Coast fever is by controlling the transmitting ticks. At one time it appeared as if Mr. J. Walker, O.B.E., late Chief Veterinary Research Officer at Kabete, might have succeeded in elaborating a practical method of provoking an active immunity by the intravenous, subcutaneous and intradermal inoculation of spleen pulp and blood collected from an affected animal. Unfortunately, the method, when tested on a large scale, proved unreliable. A certain percentage of susceptible cattle always failed to react to the injection and later succumbed when exposed to infected ticks. Another variable percentage reacted severely and died. The method, therefore, had to be abandoned.

Fencing, combined with dipping and hand-dressing, is therefore the only satisfactory means of combating the disease available. While dipping and hand-dressing alone can be used to control ticks, fencing renders their application more effective and more complete, and, in addition tends to prevent the reintroduction of East Coast fever and, of course, the

introduction of other infectious diseases.

While fencing necessitates a heavy capital outlay, it is the general experience in Kenya that this outlay is repaid by improvement in the condition of the cattle and in the pasture that results when the cattle are left out all night in paddocks.

Dipping in an arsenical fluid should be combined with thorough hand-dressing of the ears, eyelids, brush of the tail, prepuce of males, etc., parts to which the dipping fluid cannot readily gain access. Hand-dressing is of great importance in the control of East Coast fever, because the brown tick shows a marked preference for feeding in the ears, on the face and in the brush of the tail. Hand-dressing consists in clipping the long hairs and applying by hand either an oily dressing or the usual dipping fluid. One of the most satisfactory dressings is a mixture of one part of 7 per cent nicotine tobacco extract and eight parts of crude oil. Old oil from the sump of a motor car may be used.

As the brown tick usually remains on the host for about four days during the larval stage, four to six days during the nymphal stage, and up to eight days during the adult stage, dipping and hand-dressing every three days should theoretically be the ideal method of controlling East Coast fever. In practice, however, dipping every five days in a seven-day-strength dip combined with hand-dressing has proved at least equally effective. In South Africa the latter system is usually employed, although an extra hand-dressing is frequently interpolated in the five-day period.

On farms where previously no measures have been taken to reduce tick infestation it must not be thought that by the rigorous application of control measures a severe outbreak can be checked in a very short time. In practice, even under the best conditions, dipping and hand-dressing will not ensure that every tick is killed before it has fed for sixty hours, and a considerable number of losses may be experienced before the disease is brought under control. On farms where measures to control ticks are in force and tick-life has been reduced to a minimum, outbreaks of East Coast fever can never develop serious proportions. Herein lies the value of cattle cleansing.

Cases of East Coast fever may occur up to fifteen months after the last case. The difficulty that arises in practice is to determine when the last case has occurred. It is recognized that when infecting ticks become scarce cases may be atypical. Such cases have already been mentioned as being not infrequent during the course of outbreaks in clean areas. It is easy to see how such cases, occurring on a farm during the regulation 18-month quarantine period, may go undiagnosed and yet lead to the maintenance of infection in ticks. Failure to diagnose the continuance of infection may also, of course, be due to failure of an owner to submit slides, or to the submission of slides unsuitable for diagnosis; for example, slides from a decomposed carcass.

Turning Sickness

In cattle immune to East Coast fever, there occurs on occasion, in certain areas, a condition in which parasites indistinguishable from Koch's blue bodies are found in the brain. This condition is known as "turning sickness" or by its Wakamba name, *Muthioko*.

Occurrence and Etiology.—Turning sickness has only been observed in areas in which East Coast fever infection is very heavy.

All attempts to reproduce this condition experimentally have so far been unsuccessful, and it is not known whether the parasite found in the brain is identical

with that of East Coast fever, or whether it is a closely related species. The fact that engorged nymphæ, collected at death from a case of turning sickness and fed as adults on a susceptible animal, have on occasion induced an attack of East Coast fever suggests that the parasite responsible is *Theileria parva.*

Symptoms.—Symptoms of turning sickness may appear in animals that have recently recovered from East Coast fever or they may develop many years after an animal has passed through an attack of that disease.

The symptoms consist of walking in a circle, either to the right or to the left, or of giddiness. Eventually paralysis usually occurs. Cases may be acute, death occurring within a few days of the animal being noticed sick, or chronic, the animal appearing to recover from the original nervous symptoms but gradually losing condition. In oxen loss of condition is rendered more rapid by working. Chronic cases have been known to live for over a year.

Post-mortem Lesions.—Definite lesions after death are restricted to the brain and its membranes. In acute cases fresh hæmorrhages and clots are found overlying various parts of the brain or in the ventricles. On occasion clots are found in both localities. The blood vessels of the membranes surrounding the brain are engorged with blood and small hæmorrhages may be discernible in the brain substance.

In chronic cases lesions are not so noticeable. Usually, however, small areas in the brain, that differ from the surrounding tissue by appearing dry or yellowish, may be discoverable.

Diagnosis.—In order to establish a diagnosis of turning sickness, smears are made from the blood clots on the brain or from parts of the brain substance that show hæmorrhages. Such smears should show the presence of Koch's bodies. In this condition it is most unusual to find these bodies in gland or spleen smears. The blood may show the presence of rare small piroplasms.

Treatment.—No method of treating turning sickness has been developed.

SMALL PIROPLASMS

Small piroplasms are one of the commonest parasites observed in the routine examination of blood smears in East Africa. They have already been mentioned as one of the forms of the parasite of East Coast fever. However, a second species of small piroplasm, known as *Theileria mutans,* exists. This parasite, transmitted by the red-legged tick, is rarely of pathological significance. Almost all undipped cattle become infected early in life, and thereafter harbour the organism in a manner analogous to that in which redwater and anaplasmosis are carried. When a carrier animal contracts a serious disease *Theileria mutans* often reappears in numbers in the blood.

The two species of small piroplasms, *Theileria parva* and *T. mutans,* can rarely be distinguished by the microscopical examination of blood smears. During infections with the latter parasite, however, it is unusual to find Koch's bodies in the glands or spleen, hence the necessity for submitting gland or spleen smears for the diagnosis of East Coast fever.

Occasionally when a heavy infection with *Theileria mutans* has also been present, Koch's bodies have been found in the glands of calves dying from paratyphoid. Similarly, when susceptible adult cattle are exposed to a heavy infection with ticks carrying *T. mutans,* a percentage may show Koch's bodies in gland smears during the temperature reaction. All such cases are, however, so rare that the presence of Koch's bodies in gland or spleen smears must be accepted as evidence justifying at least a provisional diagnosis of East Coast fever.

Eleusine Cultivation by the Wachagga on Kilimanjaro

By J. R. CURRY, *N.D.A., Agricultural Officer, Tanganyika Territory*

The Wachagga are a hill people living on the southern and eastern slopes of Kilimanjaro. Their cultivations extend from about 3,500 ft. up to the lower edge of the forest reserve, which varies in altitude between 5,500 ft. and 6,000 ft.

The climate and rainfall vary considerably with altitude and also between the eastern, south-eastern and southern slopes. The southern slopes, and to a lesser extent the south-eastern, possess a plentiful supply of irrigation water taken from the rivers which rise in the rain-forest; the eastern slopes are poorly supplied with water, and irrigation is not important.

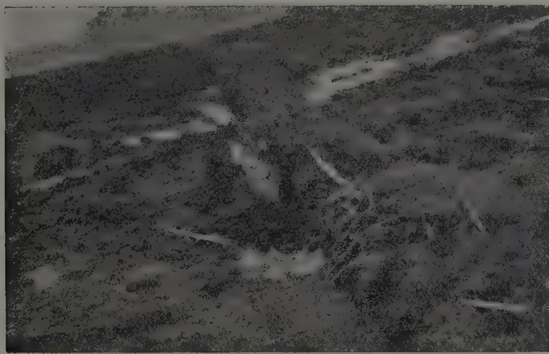
The rainfall may vary between 100 in. near the forest down to 40 in. on the lower fringe of the cultivated zone. On the southern and south-eastern slopes, where the total precipitation is heaviest, most of this rainfall is brought by the south-east monsoon, or long rains. The short rains are heaviest on the eastern slopes, so that this area has two rainy seasons of about equal intensity, both sufficient for growing such cereals as eleusine and maize. The short rains are heavier on the south-eastern slopes than on the southern slopes, but in neither locality are they sufficient for the growing of cereals.

In an area where such wide ranges of climate, rainfall and rainfall distribution occur, it has been possible for the inhabitants to develop a diversified agriculture; among the wide range of crops grown eleusine takes second place only to the banana, which is the staple food of the tribe.

In the middle and upper areas throughout the south and south-eastern slopes eleusine cannot be grown during the long rains; conditions are too wet and cold for satisfactory growth and yields to be obtained. Eleusine requires clear sunny weather at the time when the flowers have formed and fertilization occurs. The natives allege that rain-grown eleusine in the upper areas gets a "sickness"; what appears actually to happen is that the flowers fail to set seed and only empty discoloured heads are harvested. This is probably due to the pollen being washed away by the torrential rains.

This inability to grow eleusine during the rains in the high Chagga lands has evolved a system of growing it as an irrigated crop during the dry season, a practice which has evoked a great deal of comment and criticism from visitors to the district. The dry-season growing of eleusine under irrigation is one of the most interesting agricultural practices of the tribe, and although it is fraught with many dangers from soil erosion and loss of soil fertility it does constitute a division of labour throughout the year, which is in itself a desirable aim.

New land or land which has been under a long bush fallow is preferred, but owing to the pressure of population in a limited area this is not always possible, and the land is often rested for only two or three years between irrigated eleusine crops. There are exceptions to the practice of clearing bush and forest for growing eleusine, as will be described later, but large areas are cleared each year for its cultivation. Clearing, mainly done by the men, commences towards the end of the long rains in the month of June, but the women frequently help. The bush is piled into heaps and burnt; the land is then roughly broken by means of a forked hoe.



After irrigation. Effect of contour hedge can be seen

Eleusine preceding a banana grove. The banana stems and suckers can be seen, also the banana stems laid across the slope to check soil wash

Eleusine field

The real work of the women now begins. By means of small hoes or with short hooked sticks the soil is carefully broken and hoed into the finest of tilths, nearly all trace of vegetable matter being removed and placed in heaps. All this vegetable matter is burnt and the ashes scattered over the soil. The land is now ready for sowing. The seed is broadcast by the men, only occasionally by a woman; in the event of a husband's sickness a neighbour will usually be requested to do the sowing.


Wicker basket store for eleusine

As soon as the seed is sown the land is irrigated, and at the first irrigation is thoroughly puddled. The water is led at a fair velocity across the plot in a series of small parallel channels that run diagonally across the slope at intervals of about five yards and are joined by smaller channels at about six-foot intervals running very nearly at right angles to the slope. Irrigation commences at the bottom end of the plot and water is allowed slowly to trickle down the small channels from the diagonal channel. The whole time the man is checking its flow with his feet and a hoe, or with a forked stick, thoroughly puddling and mixing the soil and water. In this way the land below the last diagonal channel is irrigated; the water is then led into the second channel and the next section irrigated, and so on.

It is customary to irrigate the eleusine four or five times during the season, but in a mountain area where the rains may continue at intervals well into July or August, or where heavy "instability rains" may occur, some of the irrigations may not be necessary.

Although a great deal of the irrigated eleusine is grown on land which has been under a bush fallow, extensive areas are also grown after a yam or a maize crop has first been taken. In the upper areas maize also cannot be grown satisfactorily during the rains, and here eleusine frequently follows the yam. The land is deeply cultivated for the yam and only the heavy bush is burnt. All the rest is used as a mulch, and in addition cattle manure is added to the surface after the yams are planted. The subsequent harvesting of the crop gives a further cultivation. On clearing away the yams cultivation follows as previously described.

In the lower and middle areas where maize can be grown during the rains, eleusine is often preceded by a maize crop. Work commences before the maize is harvested; while the cobs are still green the stalks are stripped of their leaves, which are fed to the stalled cattle. The land is then cultivated and carefully cleaned between the bare maize stalks bearing the ripening cobs, the seed sown, and the land irrigated before the maize is harvested.

Land which is intended for a banana grove will frequently first be planted with eleusine, so that the reserves of fertility will be tapped for this all-important crop; for it is known that the fertility will soon be restored under the Chagga system of manuring the bananas with the dung from the stall-fed cattle. The banana suckers are planted with the eleusine at the desired spacing.

Throughout the growing season eleusine is kept free from all weed growth, although in a close-growing crop of this nature weeding is frequently a most laborious task. Weeds are given their first check when the eleusine is thinned, which is done by combing the plants with a double pronged stick, with swift short strokes. This operation not only thins out clumps of plants where the seed has been sown too thickly but it also gives a more even cover to the ground and encourages tillering.

The chief criticism of growing eleusine under irrigation is that it is wasteful of soil fertility; eleusine is seldom followed by another crop. This is done partly because it is desired to build up reserves of fertility for a future eleusine crop, but also because it is known that the land will not produce another satisfactory crop for several years. When the steepness of the slopes on which eleusine is often grown is seen it is soon realized how wasteful even the most careful irrigation must be. In former times cattle manure was sometimes applied by mixing it with the irrigation water, but this practice has entirely ceased. Further, the old people say that irrigation was done much more carefully than it is now; a parent would take disciplinary action with a son who was allowing too large a flow of water to enter the plot. Now it is a common sight to see water poured over the land in unmanageable quantities. Even to-day the great care exercised by the old people is in marked contrast to the careless and hurried methods of the younger generations. Another useful custom which has been dropped for many years was the laying of banana stems across the slope in order to check soil wash. Since 1935 measures to prevent soil erosion have been compulsory under Native Authority Rules, and it has been found that very little pressure has been needed to enforce these rules on a wide scale. Banana stems across the slope have been reintroduced, but the main measure prescribed is that contour bunds shall be made with rubbish which was formerly burnt, reinforced either with ordinary stakes or with cuttings of *Coleus kilimandscharicus*, which eventually grow into live hedges. The coleus hedge survives the return to bush, and when the land is once more cleared indicates the contours. It is thus not necessary for the African instructor to re-mark the contours on the plot.

There are three varieties of eleusine grown, and when the seed is mixed it is customary to select in the field a sufficient quantity of heads of the desired variety for next year's sowing. The heads are cut with a length of straw sufficient to allow a small sheaf to be made, and there are hung in the house until next season. When the crop is harvested the heads are removed, dried in the sun and stored in large wicker baskets plastered with cow dung. The whole harvest is never threshed at once, but taken out of the store and threshed as needed for food or beer.

Eleusine is grown as a rain-crop in the lower altitudes of the southern and south-eastern slopes and on the dry eastern slopes of the mountain. The regions in which it can be grown during the rains are approximately below 3,500 ft. in altitude and with a rainfall of less than 40

inches. Even at this altitude and comparatively low rainfall, well-drained sloping land is always selected. It is grown either as a pure crop or under widely spaced maize.

It is not definitely known why eleusine grown under irrigation is so exhaustive. The reason might be sought among the ways in which it is treated differently from other crops:—

(1) Careless irrigation on slopes, with consequent loss of surface soil.

(2) Ruining the soil texture by the puddling during irrigation.

(3) The depletion of soil humus following on the burning of all removable vegetable matter.

A great deal of importance is attached to securing a good eleusine crop. Hence the long fallows of otherwise valuable land and the careful and thorough way in which the land is prepared and cultivated. Fertility is generally restored by means of a bush fallow, but frequently eleusine is interplanted with pigeon peas, whose slow growth does not interfere with the crop. The pigeon peas persist for several years, helping to restore fertility and provide additional food.

The primary and practically the sole use of eleusine is for making beer in which bananas are also used. Beer is not only the everyday food of those elders who are sufficiently fortunate to obtain it, but no social or ceremonial function is conceivable without the appropriate supply of beer. A marriage is naturally the occasion for the consumption of large quantities, but no marriage can be contracted until every step in a complicated system of courtship is prepared by the offering and acceptance of definite quantities of beer. Thus once the initial stage of a betrothal has been reached, the day of the marriage depends, within limits, on the bridegroom's ability to produce beer in the necessary quantities.

No article on eleusine growing in Kilimanjaro would be complete without some reference to the irrigation system upon which most of it depends. From the earliest times of their tribal history the Wachagga have developed a water-furrow system which now reaches and supplies nearly every individual holding in the thickly populated southern slopes. The construction of these furrows has involved the expenditure of immense work and ingenuity. They are taken from rivers running in deep gorges, so that the inlets are often situated several miles above the areas to be served. They are brought along the banks of the gorge until they enter the inhabited areas. It is often asked why a people so fortunately placed in regard to rainfall undertook the arduous work of constructing furrows. The answer appears to be that irrigation was not the original purpose. They were made in order to bring water near the houses to save the women from the hazards of wild animals and from enemies when they were drawing water in the thickly forested river gorges.

A Kitchen for Plantation Labour

The following specification for an estate kitchen is reproduced with the permission of the Government of Tanganyika Territory, which printed the original for issue to employers of large labour forces. The kitchen displayed is one built by Mr. G. R. Foster, Agricultural Assistant, and Mr. R. Hollyer, of the Tanganyika Prisons Department, at the Kingolwira Prison Training Camp. It is noteworthy that released prisoners trained in brick-burning, building and so on at the Kingolwira Camp readily find employment.

Specification

Foundation: 2 ft. × 6 in. in concrete 1:3:6 (stone 2 in.).

Rise to ant-proof course: Burnt brick (cement mortar) 1:6 sand.

Ant-proof course: 2 ft. × 3 in. concrete 1:3:6 (stone 2 in.).

Floor: Stamped 3 in. stone, covered concrete 3 in. of 1:3:6 (stone 2 in.).

Walls and Pillars: Burnt brick (14 in.). (Outside pointed 1:4.) Sand and clay mortar. (Inside rendered cement 1:6.)

Roofing and Ridging: Galvanized corrugated iron of 24 gauge.

Materials

Estimated Quantities

Cement:

Foundation: 3 drums.

Ant-proof course and floor: 3½ drums.

Rendering and pointing: 2 drums.

Kitchen range, lintel, etc.: ½ drum.

Stone:

Foundation: 79 cu. ft.

Ant-proof course and floor: 94 cu. ft.

Stamped base for floor: 97 cu. ft.

Sand: Approx. 50 per cent of stone = 135 cu. ft.

Timber: Total requirement 30.25 cu. ft.

Roofing:

28 Galvanized C. I. Sheets 10 ft. × 3/11 × 24.

15 Galvanized Ridging 6 ft. × 15 in. × 24.

Nails, drive screws and washers, etc.

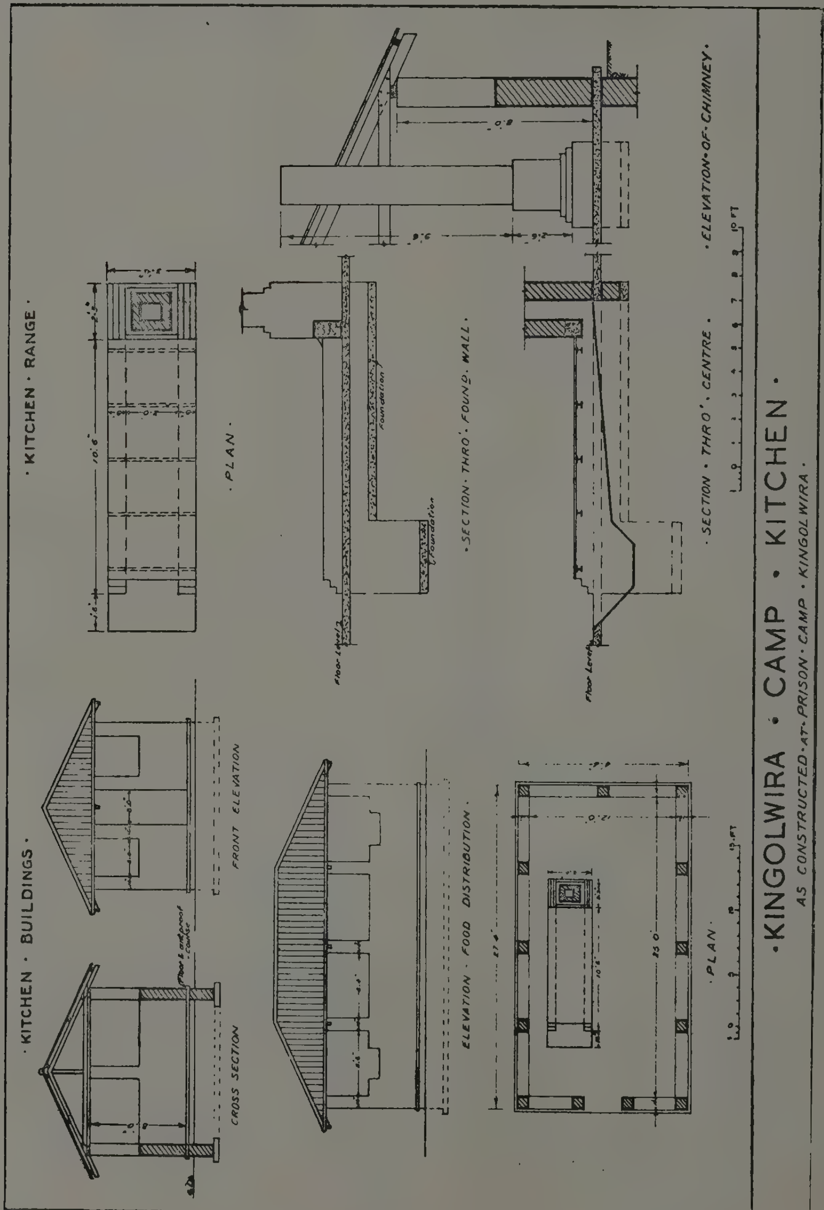
Burnt Bricks:

	Cu. ft.
Foundation to ant-proof course	184
Ant-proof course to base of pillars	355
Pillars	71
	610
Kitchen Range—	
Parallel base	45
Chimney base	25
Chimney	20
	90

Total burnt bricks: 700 cu. ft.

Kitchen Range: Iron supports discarded railway metal, six lengths 3 ft. 6 in. = 21 railway feet.

Kitchen range cover: 10 ft. × 3 ft. 6 in. iron chequer plate, *ex* scrap.


KINGOLWIRA · CAMP · KITCHEN ·
AS CONSTRUCTED · AT · PRISON · CAMP · KINGOLWIRA ·
· KITCHEN · BUILDINGS ·
CROSS SECTION
FRONT ELEVATION
ELEVATION · FOOD DISTRIBUTION ·
· PLAN ·
· KITCHEN · RANGE ·
· PLAN ·
· SECTION · THRO'. FOUND. WALL ·
· SECTION · THRO'. CENTRE ·
· ELEVATION · OF · CHIMNEY ·

Some Production-cost Figures for Native Crops in the Eastern Province of Tanganyika Territory

By N. R. FUGGLES-COUCHMAN, *B.Sc.* (*Lond.*), *Dip. Agric.* (*Cantab.*), *Agricultural Officer, Tanganyika Territory*

When the Kingolwira Settlement Centre was first opened but few data were available to show the amount of labour required in opening up and cultivating land under various crops in the Eastern Province. To obtain information on the point, Mr. Rounce, Agricultural Officer, who was then in charge of Kingolwira, laid out four one-acre plots on which the chief crops of the local native are to be grown continuously. Besides producing data on the number of man-days required for each operation on a crop, these plots will enable an estimate to be made of the profit accruing from each crop if the labour were paid and ultimately will give an indication of the period necessary to exhaust the plots under continuous cultivation. The demonstration is still in progress, but it has been thought worth while to analyse figures obtained for the first three seasons.

TECHNIQUE

The four acres are laid out on a soil typical of that found in the first area of settlement, and of the rather lower-lying soils on the Government extension farm. The soil is a friable, fertile, slightly sandy black loam, but it is somewhat heavy for groundnuts. The crops planted are cotton, sorghum, groundnuts, and maize interplanted with cassava. In all operations four men of average ability are chosen to work at their own pace, and the actual time taken by the men to complete the work is recorded. Thus figures for cleaning, planting, weeding and harvesting are obtained. The only improvements made in local native practice are the line planting of the grain crops, groundnuts and cassava. No digging or ridging of any kind is done.

COSTINGS AND YIELDS

The time taken in man-days of eight hours and the costs at an average rate of 40 cents per day, together with the yields, value of the crop and profit made, are set out below. All yields are given in pounds per acre and costs in shillings and cents. (In applying the figures to a crop grown on a non-native estate costs must be increased by 10 cents per day to cover the cost of rations.) But where a peasant works for himself, as on the holdings, and does not employ labour, the gross value of the crops is probably a better reflection of the potentialities of a district.

Maize did badly in 1936 and failed completely in 1937, as happened generally through the settlement.[1] The cassava was lifted early in order to enable the next year's crop to be planted, but yields were so low that it was decided to leave the 1937 crop in for fifteen months, treating it as a reserve food crop, in which light it is regarded by the majority of natives. Maize could not therefore be planted in 1938. However, the combined crop of maize and cassava in 1936 showed a good profit, while the 1937-38 crop of cassava would have given a much better return had there not been considerable thieving of the roots in the plot. Clearing and planting took between 16 and 30 days, the latter high figure being due to a heavy weed growth in the plot and the necessity to supply the cassava in 1937.

[1] For an explanation of this see *The East African Agricultural Journal*, Vol. II, No. 2, 1936, pp. 145–148.

TABLE I

MAIZE AND CASSAVA

TIMING ACRE RECORDS FOR SEASONS 1936–1938

	Clearing grass	Planting	Hoeing and thinning	Harvesting	Yield	Gross value	Total days and cost	Profit per acre
					lb.	Sh. cts.		Sh. cts.
Maize and Cassava 1936								
Man-days	8¾	8	6½	Maize 2	—	—	40¼	—
Cost	Sh. 3/50	Sh. 3/20	Sh. 2/60	Sh. 0/80	218	6 54	Sh. 16/10	29 12
				Cassava 15				
				Sh. 6	1,934	38 68		
						45 22		
Cassava 1937–8								
Man-days	15	15	11½	23	—	—	64½	—
Cost	Sh. 6	Sh. 6	Sh. 4/60	Sh. 9/20	2,961	59 22	Sh. 25/80	33 42

TABLE II

SORGHUM

TIMING ACRE RECORDS FOR SEASONS 1936–1938

	Clearing grass	Planting	Hoeing and thinning	Harvesting	Yield	Gross value	Total days and cost	Profit per acre
					lb.	Sh. cts.		Sh. cts.
Sorghum 1936								
Man-days	9½	2¼	6½	5	—	—	23¼	—
Cost	Sh. 3/80	Sh. 0/90	Sh. 2/60	Sh. 2/00	722	21 66	Sh. 9/30	12 36
1937								
Man-days	5	9	5	6½	—	—	25½	—
Cost	Sh. 2/00	Sh. 3/60	Sh. 2/00	Sh. 2/60	1,331	39 93	Sh. 10/20	29 73
1938								
Man-days	5¾	2½	9	9½	—	—	26¾	—
Cost	Sh. 2/30	Sh. 1/00	Sh. 3/60	Sh. 3/80	1,058	31 74	Sh. 10/70	21 04

This crop is the chief food crop of the local native, and particularly at Kingolwira, where conditions are frequently rather too dry for satisfactory maize crops. Only in 1937 was the yield of average size and the acre then gave sufficient food for a man and his wife and two children for approximately 266 days. While a certain amount of sorghum is sold by natives who are short of money, from a native point of view this crop should not be regarded as a cash crop. It will be noted, however, that for a planter in a year of average yields Sh. 20 to Sh. 30 per acre profit can be obtained from a sorghum crop of the best varieties. From the yields obtained it is obvious that to meet their needs a native family should have at least two acres of sorghum each year. The average time necessary to clean, plant and weed that area should be only 31 man days, made up as follows: 10 days for clearing, 8 days for planting (which allows for a re-planting which is not usually necessary), and 13 days for weeding.

TABLE III

COTTON

TIMING ACRE RECORDS FOR SEASONS 1936–1938

Cotton	Clearing grass	Planting	Hoeing and thinning	Harvesting	Uprooting	Yield	Gross value	Total days and cost	Profit per acre
						lb.	*Sh. cts.*		*Sh. cts.*
1936									
Man-days	8¼	4	10	10¼	2¼	—	—	34¾	—
Cost ..	Sh. 3/30	Sh. 1/60	Sh. 4/00	Sh. 4/10	Sh. 0/90	320	38 40	Sh. 13/90	24 50
1937									
Man-days	11¾	5½	15¾	12¼	2	—	—	47¼	—
Cost ..	Sh. 4/70	Sh. 2/20	Sh. 6/30	Sh. 4/90	Sh. 0/80	616	61 60	Sh. 18/90	42 70
1938									
Man-days	15	6	10	13¾	2	—	—	46¾	—
Cost ..	Sh. 6/00	Sh. 2/40	Sh. 4/00	Sh. 5/50	Sh. 0/80	750	58 00	Sh. 18/70	39 30

The figures obtained from this timing acre are of considerable interest just now when natives are complaining that there is no profit in cotton at 8½ cents per lb. of first-grade seed cotton. The crop in 1938 was above average in both quantity and quality, and at the very low price of 8½ cents per lb. of seed cotton yielded a profit of Sh. 39/30 per acre. To a native working his own land, without outside labour, a gross return of Sh. 58 per acre must be considered a highly satisfactory return, obtained by the expenditure of 47 man-days of labour. Even the gross return and profit in 1936, when a poor crop was reaped owing to several causes, are not poor. Weeding and harvesting costs account very largely for the greater cost of managing this crop; the cost of uprooting is a comparatively small part of the expenses, forming only 4 per cent of the total cost of production. Costs in 1938 were increased by the necessity for two preliminary clearings. The land was prepared for planting at the usual time, but sufficient rain did not fall for over a month, and by then the land had to be recleaned. Other costs are normal.

From the planter's point of view returns in 1937 and 1938, even at low prices, are fairly satisfactory. It is felt, however, that too many cotton planters adopt extensive methods; too frequently areas of 200 and 300 acres are undertaken with an insufficient labour force and inadequate supervision; such large areas cannot be managed properly. Much cotton is also planted too late or is not weeded sufficiently, with the result that the total yields are usually but little larger than they would be from a smaller area managed properly and at less expense. Under proper management, a profit of £90 to £180 could have been obtained from 50 to 100 acres of cotton. In order to obtain an adequate gross profit and efficient distribution of labour throughout the year, other parts of the estate should be planted with grain crops or legumes to the benefit of the soil and economic management of the farm.

TABLE IV
GROUNDNUTS
TIMING ACRE RECORDS FOR SEASONS 1936–1938

Groundnuts	Clearing grass	Planting	Hoeing and thinning	Harvesting	Shelled nuts yield	Gross value	Total days and cost	Profit per acre
					lb.	Sh. cts.		Sh. cts.
1936								
Man-days	8¼	5	7	38½	—	—	58¾	—
Cost ..	Sh. 3/30	Sh. 2/00	Sh. 2/80	Sh. 15/40	420	42 00	Sh. 23/50	18 50
1937								
Man-days	5	33	—	Failed	Failed	—	—	Loss
Cost ..	Sh. 2/00	Sh. 13/20	—	—	—	—	—	—15 20
1938								
Man-days	12½	17	15½	17¼	—	—	62¼	—
Cost ..	Sh. 5/00	Sh. 6/80	Sh. 6/20	Sh. 6/90	389	31 12	Sh. 24/90	6 22

This crop is considered to be of value as a rotation and food crop at the settlement centre, as well as providing a certain amount of cash. To the native mind a disadvantage of the crop is the amount of labour necessary to harvest it, but with the Bunch type of groundnuts this is reduced to a reasonable figure. In 1936 the native spreading variety was planted, and while the cost of planting was reduced by the wider spacing, the cost of harvesting was more than double the figure for the Bunch variety. The cost of planting the Bunch type should be only half the figure shown, as a complete re-planting was necessary. Yields in neither year were average, due largely to the soil not being ideal for the crop. On a field scale on suitable land the yield per acre in 1938 was very nearly double that for the timing acre.

For the native's dietary the crop is a useful one, in that he is growing a fair quantity of a valuable fatty food. For their cash return groundnuts cannot be considered as valuable a crop to the non-native planter as grains or cotton, nor, from costs of other legumes in a field scale, as cowpeas, green gram and tepary beans. Mechanical aids to lifting the crop would possibly increase the profit per acre. The value of the crop in the rotation must not be forgotten, as it ensures a certain amount of digging of the land. However, given suitable soils, average yields and a price of 10 cents per pound, groundnuts should show a profit of from Sh. 25 to Sh. 30 per acre.

DISCUSSION

From the foregoing tables the following average figures for each operation for each of the four crops considered are obtained:—

TABLE V
AVERAGE MAN-DAYS REQUIRED PER ACRE

Crop	Clearing	Planting	Weeding and thinning	Harvesting	Uprooting	Total
Cassava	12	12	9	19	—	52
Sorghum	6	4	6½	6½	—	23
Cotton	11*	5	12	12	2	42
Groundnuts	8½	11†	11	28	—	58½

*Includes a second clearing in 1938; average nearer 9 days.
†Includes a complete replanting; the average ought to be nearer 7 days.

For the two main crops, sorghum and cotton, between 10 and 14 days must be considered necessary to prepare the land and to plant the crop. This figure can be applied to maize and other widely spaced crops. The cotton crop requires twice as much labour to be expended on weeding, thinning and harvesting as the sorghum crop. The total man-days required to clear, plant and weed one acre of each of the three crops, sorghum, cotton and groundnuts, is 74 man-days. The minimum acreage of these crops which should be grown by a native at the settlement centre is two acres of sorghum, one acre of cotton and one acre of groundnuts, which would require the expenditure of 91 man-days only, excluding harvesting. Those days will be spread over a period of 6 to 6½ months, which gives an average of 15 man-days of labour per month to manage four acres of land. There should be no very serious clashes in the various operations. Sorghum lands can be cleared in December and planted in January or early February. Before they are weeded the cotton land can be prepared and planted, and the sorghum is then weeded or, if the rains delay, the sorghum may be weeded before the cotton land is planted. Following those operations the groundnut land can be prepared and planted, and cotton then weeded. The following table shows roughly how labour would be spread out over eight acres of land, including one acre of cassava, two acres of sorghum, one acre of maize, three acres of cotton and one acre of groundnuts:—

TABLE VI

Estimated Labour in Man-days from November to June on an Eight-acre Holding

Month	Clearing	Planting	Weeding	Uprooting	Total
November.. ..	Cassava 12	Cassava 6	—	Cotton 6	24
December ..	Sorghum 12	—	Cassava 3	—	15
January	Cotton 16½ Maize 6	Sorghum 8	—	—	30½
February	Cotton 16½	Cotton 15 Maize 4	Sorghum 4	—	39½
March	Groundnuts 8½	Groundnuts 7	Cotton 9 Sorghum 4 Maize 2 Cassava 3	—	33½
April	—	—	Groundnuts 3½ Cotton 9 Sorghum 4 Maize 2	—	18½
May	—	—	Groundnuts 3½ Cotton 9 Maize 2	—	14½
June	—	—	Groundnuts 3½ Cotton 9 Cassava 3	—	15½

It will be seen that, providing they do a good eight-hour day, even in the rush period of February, 20 days are the most a man and his wife would require to work in any one month to manage eight acres. Unfortunately, in practice, the natives are rarely lucky enough to have conditions which allow the above plan to work out exactly, nor do natives usually work a full eight-hour day. But these timing acre figures do indicate what can be expected of an energetic native and his wife. A second wife and children would enable the work to be kept well in hand.

TABLE VII

Gross Returns Received by a Native from Eight Acres Planted in 1938

Crop	Area	Yield	Gross cash value
	Acres	*lb.*	*Sh. cts.*
Cassava	1	2,961	59 22
Sorghum	2	2,116	63 48
Maize	1	1,000*	30 00
Cotton	3	2,250	174 00
Groundnuts ..	1	389	31 12

*The yield of maize is a nominal figure.

The figures given in Table VII above are obtained from the yields in 1938 on the acre plots, and serve to demonstrate the quantity and value of produce a native farmer is able to produce if he organizes his work according to Table VI, does not manure, and uses only the native hoe for cultivation. If the full eight acres is planted the native should obtain more than ample supplies of his staple foodstuffs and a sum of cash from his cotton which, to the average native in Morogoro District, is comparatively large. The use of manure could increase the yields, and if the native is in a position to use cattle for ploughing and cultivating he would reduce the time taken for much of the essential work and possibly increase the yields as well.

The demonstration has not been of long enough duration to show exhaustion of, or fertility changes in, the land; nor are changes in the texture of the soil yet noticeable. Differences in crop yields so far can be largely attributed to climatic factors. It is doubtful in fact whether any noticeable reduction in yields will occur for some years, as the land is of good quality.

Summary

Figures of man-days required to grow and harvest four crops have been collected from timing acres. These show that grain crops and cotton require from 10 to 14 man-days to prepare an acre and to plant the crop. Satisfactory profits can be shown from all crops, with the possible exception of groundnuts, which in the experiment were planted on somewhat unsuitable soil.

The figures indicate that a native can manage four acres of the crops under notice with 91 man-days of labour, spread over six months, and that eight acres of land planted to sorghum, maize, cotton, groundnuts and cassava should be within the powers of a native and his wife. The plots are being cropped continuously and no signs of a reduction in fertility are yet apparent.

Acknowledgments

I wish to acknowledge the fact that the demonstration was originally planned by Mr. N. V. Rounce, Agricultural Officer, and record that Mr. R. B. Silcock, Agricultural Assistant, has been responsible for the collection of the figures on which this article is based. His assistance is gratefully acknowledged.

Review

SOIL EROSION IN MANY LANDS

During the academic year 1936-37 Dr. A. Grasovsky of the Palestine Forest Service toured a number of countries in three continents to study forestry problems of particular concern to Palestine, especially those related to "the control of erosion and the building up of forest soil and cover in rocky ridges and slopes degraded by overgrazing and overcutting." In an Imperial Forestry Institute Paper (No. 14, "A World Tour for the Study of Soil Erosion Control Methods," University of Oxford, 1938; price 5/-), Dr. Grasovsky has set down some of his experiences, laying particular emphasis on points that appeared to him to be characteristic of, or peculiar to, the various countries and regions visited. Unfortunately, the chapters are disconnected, so that although each is full of interesting information the reader is left to weigh the evidence thus presented, and at the end to ask himself how much of what he has read can be applied to the particular forestry or erosion problems that interest him most. The reviewer is most interested in those problems of erosion that arise from overstocking, and does not grudge the time spent in picking out some of the main points relevant to this part of the subject, but students of this and of any other phase of the erosion problem complex are recommended to study the bulletin for themselves.

It is interesting to note that the African native is not exceptional in his indifference to the ravages of erosion. In most parts of the United States of America the main work of the officer in charge of anti-erosion operations still consists in "selling the idea"; that is, convincing the local community of the necessity for erosion control. Colorado farmers had to be offered material inducements before they would consent to be assisted, and "complaints were almost all that they contributed to the carrying out of the work in its early stages." On the other hand, Ceylon may be considered as "erosion conscious," while in Japan there is no erosion due to mismanagement of the soil.

Effective control of erosion must be based on comprehensive knowledge of the causes of the misfortune and of the most efficient ways of repairing the damage. It is in the United States that the most thorough experiments to gain this knowledge are being undertaken. It is almost with a feeling of awe that one reads of the work of the California Forest and Range Experimental Station, where the installation of a large set of twenty-six lysimeters, each measuring 10 ft. 5 in. by 20 ft. 7 in. by 6 ft. involved work of such dimension that the inhabitants of California suspected the government of secretly building a fort on the mountain. In no other country are there comparable experimental stations; in most countries knowledge is gained by practical attempts at reclamation, some of which, however, prove to be errors rather than trials. Thus, terraces built of earth and liable to be destroyed or damaged by every fall of rain do more harm than good, and attempts to plant up eroded land with timber trees are usually foredoomed to failure. How modern nearly all anti-erosion measures are may be judged by the remark that the "afforestation of the Etawah district (of the United Provinces) may be regarded as one of the oldest pieces of ravine reclamation work carried out in semi-arid regions during modern times." Yet this was only begun in 1912.

In every chapter are points of general interest; as, for example, the statement

that "it does not appear that the Sahara is encroaching on new territories, nor that the desiccation that has been causing alarm can be attributed to any measurable change in climatic conditions." On the contrary, "there are many local indications that vegetation is slowly invading the Sahara, and generally there is no ground for the alarm that has been expressed." In fact, the real deserts of the earth are not growing, but everywhere in semi-arid lands the unwise activities of man are degrading vegetational cover and establishing local desert conditions.

A main point relevant to erosion due to overstocking that stands out in chapter after chapter is the paramount importance of controlling grazing. To quote from the chapter on Colorado: "On the whole, it seems not unlikely that adequate control and management of grazing lands will ultimately be found at least as successful a procedure as artificial re-seeding. Indeed, it has been definitely proved that when grazing is controlled, the natural vegetation invariably responds, the rate of progress in the succession depending largely on the amount of rainfall and the type of soil."

One gathers that Dr. Grasovsky, who is a forester, does not like to see cattle in forests. On the other hand, he has no objection to open grassland. Referring to one experiment he says, "(*a*) there is scarcely any run-off from the ungrazed forest; and (*b*) there is more run-off from the forest open to controlled grazing than from the grassland open to controlled grazing." He realizes that evaporation from various types of tropical vegetation, especially broad-leaved trees, may be very high, and in lowlands he considers that a ground cover of grass is the best form of protection for catchment areas. On the other hand, "in mountains, where evaporation from tropical vegetation is much less . . . water conservation and control of soil erosion are best secured under a mixed forest."

Elsewhere he condemns expensive works when simple control measures would be as effective: "It seems, then, that in such areas [Etawah, United Provinces] protection against overgrazing and fire is all that is required to re-establish a ground cover and arrest erosion. . . . The construction of dams, terraces, etc., and the planting of species of more valuable kinds (of timber trees) but pertaining to a higher stage in the succession, must be regarded as uneconomic, and will usually result in failure." Again: "The natural re-vegetation of badly eroded areas, especially in arid regions, is always a lengthy process, though in the long run it is undoubtedly the most economic means available for rehabilitating the soil."

No serious student of soil erosion can afford to ignore this stimulating travel book.

H. E. H.